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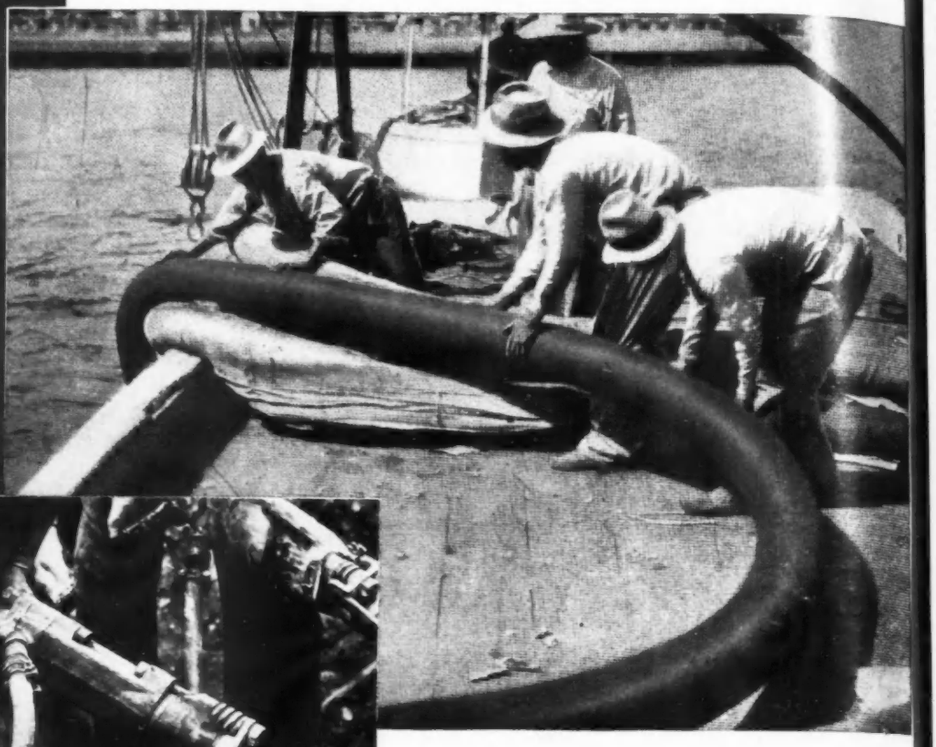

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THE CONTROL OF POWER IN LARGE INTER-CONNECTED ELECTRIC SUPPLY SYSTEMS.

By T. F. WALL, D.Sc.

(*Continued from page* 164.)

IN this article a brief survey is given of the principal contents of the previous instalments and some reference is made to other aspects of the problems of the control of power in electric supply systems. Such problems comprise not only the normal switching processes of consumers' circuits and the interconnection of supply systems by means of circuit breakers and fuses, but also include the automatic control of surges such as those due to atmospheric storms and short-circuits, with the consequent dangers to the stability of the systems.

Since the opening of an electric circuit to interrupt a current will, in general, involve the production of some form of arc and the consequent development of hot and ionised gases, a study of the significance of the "space charge" as influencing the operation of circuit breakers has not only become essential in recent years for the appropriate design of all types of heavy-duty circuit breakers but has also led to a clearer comprehension of the essential conditions which the quenching devices for rupturing the arc must fulfil in order that circuit breakers shall be able to control adequately and efficiently, and with the minimum cost and space requirements, the immensely high powers of modern interconnected systems. A striking example of the artificial control of the space charge for special technical purposes is the use of the grid-control in mercury-arc rectifiers, by means of which the range of possibilities of this type of rectifier has been increased to an astonishing extent.

Fig.62.(a)

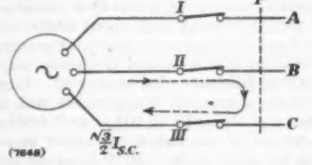


Fig.62.(b)

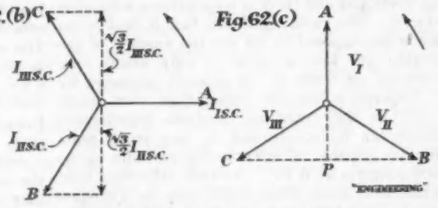


Fig.62(c)

A study of the phenonema of discharge from electrodes in an evacuated space has clarified the characteristic features of the glow discharge and has shown that when the current density at the cathode surface reaches a certain limiting value, the discharge becomes abruptly converted from the glow to the arc and the whole character of the discharge changes fundamentally. The pressure drop at the cathode has formed the subject of concentrated research which has resulted in the design of the "cathode drop" surge arrester and this appliance has now been developed as a highly reliable and effective means for dealing with surges due to atmospheric inductive disturbances and recent tests have also shown that it can deal with direct lightning strokes into the line, involving currents of the order of 200,000 amperes.

A further successful development in recent years is the design of non-resonating transformers in which the capacitance of the windings is so distributed that the concentration of pressure at the end turns becomes eliminated when a surge from the line reaches the high-tension terminals of the transformer.

When a short-circuit occurs on a large power-supply system one or more of the generators may lose its synchronising torque either partially or completely and, in general, the result will be that the machine or machines will begin to fall out of step. Unless the circuit breaker then acts with sufficient speed, the generator will lose its synchronous speed and, in consequence, will have to be shut down. If, however, the short-circuit is cleared with sufficient speed the machine will recover its synchronising torque and, under the control of the damping grids, will eventually settle down to steady running conditions through a series of decaying oscillations. These oscillations, however, will mean heavy current surges and may trip the circuit breakers unless the trip gear is designed so that it will not respond to such surging currents. Calculations show that, in general, if the time required for the circuit breaker to clear the fault is not greater than about 0·25 second, the machine may be expected to remain in step.

When a circuit breaker is opening, the arc current will pass through zero at the end of the half-cycle and the problem of the designer is to prevent the arc from re-igniting as the voltage across the switch contacts increases. This problem embraces, on the one hand, the requirements that the insulating property of the space between the circuit-breaker contacts shall be established with the highest possible speed and on the other hand, that the gap between the switch contacts shall also increase as rapidly as possible. The insulation of the gas-filled space between the switch contacts when opening a circuit depends upon the type of break employed. Test data show that while in the case of an oil-switch the insulation strength is only a small fraction of that of clean dry air, in the case of the "expansion" type of switch the insulation strength shows a much closer approach to that of the air. There are two main factors which operate to reduce the insulation strength, viz., (i) the space charge between the electrodes, and (ii) the low density of the gas or, what is equivalent, the high temperature in the space between the electrodes. These aspects of the insulation strength have been the subject of intensive research during recent years and have led to a scientific explanation of the relative merits of the different methods for quenching the arc. It has been shown, for example, that for an arc burning in hydrogen (which occurs when oil-gas or water vapour is produced in the switch), the core of the arc in an expansion type of breaker when carrying a current of 2,000 amperes had a diameter of about 1·5 mm., corresponding to a current density of about 100,000 amperes per square centimetre, the temperature being about 15,000 deg. K. For an arc burning in nitrogen (or air) the temperature is about 5,500 deg. K., while in the case of volume cooling of the arc (such as the low oil-content type of circuit breaker) a temperature of about 20,000 deg. K. is reached and a current density of more than 500,000 amperes per square centimetre.

For the control of electric power systems, a great variety of switches is necessary. These may be divided into two groups, viz., (i) those which operate as isolating switches and do not carry current when operating, but only serve to isolate the line, transformer or other apparatus from the live supply terminals; (ii) those which are required to operate under load. This latter group may be sub-divided into those which only operate under the normal working load of the system and those which are required to interrupt short-circuit currents.

Although isolating links are only intended to operate when no current is flowing through them, yet, under certain conditions they may have to operate with a small current; for example, links for 6 kV to 10 kV systems up to 4 amperes, and for 15 kV to 30 kV systems up to about 2 amperes. When the magnetising currents of transformers are to be interrupted the magnitude of such currents must be small since they are highly inductive and as examples of the permissible values it may be stated that at 10 kV the magnetising current of a transformer of rating not greater than about 250 kVA may be interrupted while at 30 kV the rating may be about 600 kVA. For supply pressures less than 10 kV the permissible kVA increases, so that for 3 kV the rating may be about 600 kVA.

The most exacting conditions under which a circuit breaker must operate are those of a short-circuit and particularly a short circuit at full excitation of the generator. Transient currents may then be developed having a magnitude many times greater than the normal operating current of the system and, in consequence, the energy which must be dissipated at the contact surfaces and so absorbed by the cooling medium becomes immensely greater than that corresponding to the normal current load. The duration of a short-circuit on a system is made up of the time t_1 required to actuate the protective relay and the time t_2 required to open the circuit breaker. The interval t_2 is to be taken to be the time between the imparting of the rupture impulse to the circuit breaker and the extinction of the arc. The rupturing time of the circuit breaker on a system is the main factor in grading the time-lags of the relays and when selective relays are used having minimum time action, the duration of a short-circuit is practically dependent only upon the rupturing time of the breaker itself.

If it is desired to predict the performance of a circuit breaker on a short circuit, it is not sufficient to estimate the pressures so developed by experiments with small current values. The electrical pressure of the arc will be largely determined by the gas pressure and can, therefore, only be found by actual full-scale tests. It is favourable for the interruption if, with rising currents and rising magnitudes of the released energy, the gas pressure and consequent electrical pressure of the arc also rise. The nature of the gas in which the arc is formed has a great effect upon the burning voltage of the arc and on the ignition voltage. Hydrogen with its high heat conductivity gives from 5 times to 10 times the voltage of an arc in air. Arcs formed under oil generate hydrogen gas and this fact largely accounts for the high quality of the current interruption characteristics of oil switches.

From the time of the Frankfurt Exhibition of 1891 until the end of the century, all switching during service was done by means of the lever type of air breaker, and the automatic interruption in the case of a short circuit was ensured by fuses. In the case of all lever types of circuit breakers, with or without horns, the relative motion between the arc and the quenching medium (in this case air) was caused by the rising of the arc as a result of the upward trend of the heated air and the dynamic action of the current loop. By the end of 1893, however, manufacturers in America had begun to adopt the first device expressly designed for producing the necessary relative motion between the arc and the surrounding air. In this case the moving contact consisted of a plunger which was introduced into a close-fitting tube of insulating material, the fixed contact being at the base of this tube. When the plunger contact was rapidly pulled out, a partial vacuum was created in the cylindrical tube so that a current of air was drawn through the opening as the contact emerged and the arc thus became cooled all round its surface and so extinguished. So long as the power was not too great, this type of switch worked well. At a very early date it was sought to use a liquid instead of air as the quenching medium in the path of the arc and the first oil circuit breaker appears to be that built by Ferranti in 1895. In this case, the rod moved downwards for switching off, so that the fixed upper contact at which the arc was struck remained in air, while the moving contact was drawn into the oil. Owing to the displacement of the oil by gas bubbles generated by the arc, the upper contact became flooded with oil during the switching process.

In oil-tank circuit breakers, the oil has to serve as an insulator as well as for quenching the arc, so that immense quantities of oil are necessary when they are used for very high-tension systems, and as much as 20 tons of oil per phase are required for 200-kV systems. The use of such large quantities of oil is particularly undesirable in view of the possibilities of ignition if an explosion should take place in the container. For very high-tension systems each phase of a three-phase circuit breaker must be operated in a separate tank, and in order to obtain a sufficiently large break the contacts must be sub-divided to give several breaks in series.

It is of interest to note that direct-current systems are much more difficult to operate than

alternating-current systems of the same rating, and for a direct-current circuit a magnetic blow-out is used. A direct-current switch cannot be operated satisfactorily in oil since, apart from the dangerously high pressure rises which would be caused in that way, it has been shown that the oil will become decomposed by the action of a direct-current arc.

It has been pointed out that the oil-tank circuit breaker uses oil not only for extinguishing the arc, but also for insulating the contacts from each other and from the earth, so that the oil filling in such switches cannot be reduced appreciably by any change in the design, especially in the case of switches which are used for very high voltages. During the last decade the technique of circuit-breaker design has experienced a revolutionary change. The primary cause of this development is the fact that several severe explosions in circuit-breaker tanks have had disastrous effects on the operation of the systems and in some cases have caused the death of members of the control staff. In recent years, strenuous efforts have been made to eliminate oil altogether from circuit breakers and switchgear plant and a notable step forward was the introduction of the low oil-content type of switch. The amount of oil for such a switch is only about one-hundredth part of that required for an oil-tank switch of corresponding characteristics because the oil filling is only used to extinguish the arc, insulation from earth being provided by means of porcelain pillars. It is to be observed, however, that the fundamental drawbacks of the oil-tank circuit breaker are only reduced, but not eliminated, by the use of a small oil filling. In any switch having an oil filling faulty operation may produce so much gas or vapour that an explosion is possible, and even a small amount of oil can have disastrous effects when the switch becomes damaged through a fault or through excessive stresses.

An important example of the principle of arc extinction by means of a small amount of oil is the "oil-impulse" circuit breaker, such as is used on the 287-kV transmission line from Boulder Dam to Los Angeles as well as on the 138-kV side of the auto-transformers at the Los Angeles end of that line. These circuit breakers are capable of operating with an extremely low time rating of 3 cycles of the 60-cycle supply, that is, in 0·05 second. This time is measured from the moment the relay trip coil becomes energised to the moment at which the arc is extinguished. In these circuit breakers extinction of the arc is obtained by means of a blast of cold oil which is driven across the arc from a mechanically operated piston. Many single-phase oil-impulse circuit breakers are in use in the United States for railway service operation on 11 kV systems at 25 cycles and have an interruption time of 1 cycle, that is, 0·04 second. During the last few years the need has appeared for switches having an interruption time which shall be intermediate between the normal time of 8 cycles and that of the highly special and very expensive switches rated at 3 cycles. For this purpose, oil-impulse switches are being constructed in which the oil blast is generated by special generator breaks instead of by the mechanically driven piston. In the absence of extreme speed requirements, this self-generated oil-blast appears to be a satisfactory solution.

While the low oil-content type of switch has proved to be a great advance on the oil-tank type it does not entirely eliminate the objections raised to the use of oil for switch purposes and much research has been carried out with a view to using some other liquid of non-inflammable quality such as some kind of non-inflammable oil or water. Investigations which have been carried out with non-inflammable oil, however, have shown that no useful progress is likely to be made in this direction. Early tests showed that among inorganic substances only water is possible for the purpose. Other liquids, such as mercury and those having a silicon base, were ruled out on account of conductivity, poisonous nature, or moisture sensitivity. The number of organic liquids which are suitable is much greater, but they are in most cases inflammable and offer almost completely inferior properties and higher costs than normal switch oil. As regards water, it has been objected that this is not suitable for high-tension switches, but the objection is partly answered by the fact that such switches have been operated at pressures up to 45 kV for many years. This pressure, however, does not represent the upper limit, and experiments indicate, in fact, that there is no upper limit to the pressure for which water switches may be used. Water as well as oil has the characteristic property of producing hydrogen gas at the high temperatures of the arc and the high heat conductivity of hydrogen is a most valuable property in producing a powerful cooling action on the arc and thus forcing its extinction. To the electrical conductivity of water, small as it is, may be referred the fact that, in contrast with oil, when switching off transformers, cables, or overhead lines, there is practically no excess pressure rise and this fact has been fully confirmed by actual tests. Also to the conductivity of water is to be referred the absence of pressure and current surges when switching on, and this is particularly noticeable for pressures up to 12 kV. These favourable characteristics of water can only be utilised under the assumption that it is possible to avoid the unfavourable characteristics such as its high solvent power, high capillary effect, variability of conductivity, and corrosion dangers. Practical experience over many years has now proved that these disadvantages have been fully overcome and it is claimed that for pressures up to 60 kV water is the ideal liquid for quenching the arc in circuit breakers. Actually, a water-base liquid known as "Expansene" is used. It was formerly thought that the only advantage of water over oil was that it is non-inflammable and that in all other respects it must be considered to be inferior, but long practical experience has shown this view to be incorrect. The use of water eliminates all carbon material so that there is no danger of fumes being developed and there is no poisonous substance produced. The most significant fact is that when water is decomposed by an arc the amount of gas generated per kilowatt-hour is only about one-seventh to one-tenth of the amount produced by oil. Experience has also shown that when water is used as the quenching medium high-tension switches can be constructed in very small units which are capable of interrupting currents up to 60,000 amperes at 6 kV. Another fallacious view was that a persistent flame might cause the hydrogen to burn when the arc was formed and the water vapour became dissociated, but actual tests have disproved this view, the explanation being that when hydrogen is mixed with steam it is not inflammable and neither is it explosive, because even if accidental ignition occurs at one place, the immense absorption of heat by the steam mixture will prevent such ignition from extending.

Air-Blast Circuit Breakers.—In nearly every type of circuit breaker the rupture of the arc is effected by subjecting it to a flow of gas or vapour and since an arc can only be maintained at extremely high temperatures, effective cooling will destroy the necessary condition for its existence. The heat of the arc will pass outwards to the cooling medium while within the arc itself the quenching medium will be decomposed into ions and electrons thus absorbing an immense quantity of heat energy. In the majority of circuit breakers the quenching medium is formed and put into motion by the arc itself and such preparatory action takes time and consequently limits the speed at which the extinction can take place. Outstanding features of the air-blast type of circuit breaker are that the mass of the moving parts is relatively very small and that the quenching of the arc is obtained by driving a blast of compressed air across its path. This was the first type of circuit breaker that made it possible to interrupt the current effectively within from 0·04 second to 0·05 second from the moment at which the protective relay commenced to become energised.

Of all the means which have been devised to maintain the stability of a supply system when a service fault occurs, the most effective is the rapid interruption of the current to the fault and for this reason it is essential to provide circuit breakers having a time of interruption as nearly one half a cycle as is technically possible, so that the arc shall be finally quenched at the first passage of the current through its zero value. In this way the risks of disturbance to the stability of the system, as well as the corresponding current and voltage surges, are reduced to a minimum and largely eliminated. It is also to be observed that when a short-circuit occurs between two overhead lines the electromagnetic forces will cause the arc to travel along the line, so that high-speed rupturing of the current will reduce the distance travelled by the arc and consequently the dangers will be localised at the place of the original fault. A further important fact is that arcs are generally confined to line insulators and if the arc is ruptured at the highest possible speed, these porcelain insulators may remain undamaged, whereas if the arc persists for only a few tenths of a second the insulator at which the arc is formed will most probably be destroyed.

The air-blast circuit breaker is similar in principle to the oil-impulse switch as used in the United States, the main feature of the modern air-blast switch being the use of compressed air supplied from a reservoir at a suitable pressure.

Recovery Voltage.—Immediately after the arc has been quenched, the voltage across the contacts of the circuit breaker will begin to assume the corresponding momentary value of the generator e.m.f. and the change of the p.d. across the contacts from the quenching pressure of the arc to the generator e.m.f. will usually be made by means of a transient high-frequency oscillation. These phenomena are of great importance in determining whether the arc will re-strike before the circuit-breaker contacts have become fully open. Since the stator winding of the generator will have distributed capacitance to the frame, that is to earth, this capacitance in combination with the leakage reactance of the windings will form an oscillating circuit and from the results of a large number of tests it has been found that the natural frequency of modern power-station generators has an average value of about 20,000. The natural frequency of a 100-kVA transformer is about 20,000, a 30-kV unit about 30,000 and a 6-kV unit has a still higher frequency. For current-limiting reactances the natural frequency may be from 20,000 to 200,000 cycles per second. Current and pressure instrument transformers will have a capacitance of the order of 100×10^{-12} farad and the capacitance of the naked conductor in series may be of the order of 30×10^{-12} farad per metre. Whether the arc will re-strike will depend upon whether the insulation strength of the gap between the switch contacts is greater than the pressure due to the super-position of the high-frequency voltage and the low-frequency voltage wave of the generator.

Automatic Re-Closing of Circuit Breakers.—For the purpose of eliminating interruptions of the supply it has been found that an automatic and rapid re-closing of the circuit breaker has provided a very promising means for preventing such interruptions. For the utilisation of this principle it is essential that a short rupturing time shall be possible, such as is now obtainable with the oil-impulse circuit breaker and the air-blast type. On the Continent, 80 per cent. of all earths due to atmospheric storms have been made harmless by means of the Petersen coil. In America, however, it is customary to earth the neutral of the system permanently so that every earth on the line becomes a short-circuit and this means that the circuit breaker will trip. It was in consequence of this use of a permanently earthed neutral that the problem of rapid re-closing of the circuit breaker first arose and this problem has been solved by applying a rapid re-closing device to the oil-impulse circuit breaker. Statistical records have been compiled regarding the distribution of the causes of interruptions of the supply for Swiss systems operating at 50 kV and 80 kV, respectively. These records are in good agreement with similar records obtained in America and South Africa on systems operating at 132 kV and the important fact has been disclosed that only about 7 per cent. of such disturbances are of a permanent character.

Power Rating of Circuit Breakers.—The power interrupted by one pole of a circuit breaker is defined as being given by the product of the r.m.s. value of the interrupted current and the r.m.s. value of the recovery voltage. The following considerations will make clear the significance of

this definition. Suppose a circuit breaker is operating to interrupt a three-phase short circuit as indicated in Fig. 62 (*a*), on page 221, in which P denotes the position of the short circuit, and let I_{sc} denote the r.m.s. value of the short-circuit current per phase. When the current in phase I is passing through its zero value, the current vector diagram will be as shown in Fig. 62 (*b*) and the phase pressure diagram for the same moment will be as shown in Fig. 62 (*c*). At this moment the currents in phases II and III will each be equal to $\frac{\sqrt{3}}{2} I_{sc}$, and will be of opposite sign, so that there will be a circulating current in phases II and III of this magnitude, as shown in Fig. 62 (*a*). The pressure at P will then be given by the point *p* in the pressure vector diagram, Fig. 62 (*c*), so that the recovery voltage for phase I will be given by A*p*, that is, $\frac{3}{2} V_p$, while the voltage for each of the phases II and III will be given by the magnitude C*p* and B*p*, that is, $\frac{\sqrt{3}}{2} V_p$. The volt-amperes interrupted by phase I will then be defined as $I_{sc} \cdot Ap = \frac{3}{2} V_p \cdot I_{sc}$, while the volt-amperes interrupted by each of the two phases II and III will be

$$\frac{\sqrt{3}}{2} I_{sc} \times \frac{1}{2} CB = \frac{\sqrt{3}}{2} I_{sc} \frac{\sqrt{3}}{2} V_p = \frac{3}{4} I_{sc} V_p,$$

where V_p is the phase pressure. Hence the total volt-amperes interrupted by the circuit breaker will be

$$3 V_p I_{sc}$$

and the volt-amperes interrupted by one phase will be $\frac{3}{2} V_p I_{sc}$.

If the power rating of a circuit breaker is stated to be the same for a two-pole short circuit as for a three-pole short circuit, this implies that the current interrupted by a two-pole short circuit is $\sqrt{3}$ times that interrupted by a three-pole short circuit and the recovery voltage for a two-pole short circuit is $\frac{1}{\sqrt{3}}$ times that of a three-pole short circuit. Since, however, a circuit breaker is generally more severely stressed by an increase of short-circuit current than by an increase of pressure, it is seen that, under these conditions, a two-pole short circuit will be more severe on the circuit breaker than a three-pole short circuit. Consequently, it by no means follows that the power rating for the interruption of a three-pole short circuit can be satisfactorily controlled when a two-phase short circuit is to be controlled.

As an example of the performance of a circuit breaker on short circuit the following data are interesting:—The normal rating of the circuit breaker was 6 kV line pressure and 1,000 amperes. Oscillographic records showed that the peak value of the short circuit current on closing the switch was 42 kA; the r.m.s. value of the subsequent current was 16·8 kA; the duration of the arc was 20 milli-seconds; and the recovery voltage measured from the star point was 7·2 kV. The power which the switch controlled on short circuit was therefore:—

$3 \times 7{\cdot}2 \times 10^3 \times 16{\cdot}8 \times 10^3$ volt-amperes; that is, 360 mVA.

Some typical values for the short-circuit power rating of four three-pole high-speed air-blast circuit breakers are as follows:—Normal rated pressure 220 kV, normal rated current, 630 amperes, short-circuit power, 2,500 mVA; normal rated pressure, 87 kV, normal rated current, 640 amperes, short-circuit power, 1,000 mVA; normal rated pressure, 11 kV, normal rated current, 4,000 amperes, short-circuit power, 400 mVA; and normal rated pressure, 6·4 kV, normal rated current, 400 amperes, short-circuit power, 100 mVA.

For a low oil-content circuit breaker the normal rated pressure was 220 kV, the normal rated current 600 amperes, and the short-circuit power 1,500 mVA.

(To be continued.)

POSTAL SERVICES TO SYRIA.—The Postmaster General has announced that the postal services to Syria, including air mail and parcel post, have now been restored.

LITERATURE.

Glossary of Technical and Vernacular Terms in Connection with Irrigation in India. First edition, revised. Simla: Central Board of Irrigation.

FROM time to time the Government of India and the Provincial Governments have published papers on technical subjects: those on irrigation are particularly valuable, for in this branch of engineering India has been a pioneer in modern developments. In these papers many vernacular terms have been used, and the Central Board of Irrigation has issued the volume under review to provide the necessary explanations. The use of vernacular terms often arises from mental indolence on the part of authors and, be it noted, it is not generally the fault of those whose mother tongue is the vernacular; Indians who write English, though apt to be profuse, are careful in their choice of words. Not that the introduction of vernacular words is to be deprecated, if they serve a useful purpose; Greek and Latin roots are the foundations of most scientific words and terms. Here is an opportunity to find new roots which, provided they are carefully chosen, might further enrich the English language and at the same time foster that feeling of successful co-operation with other members of the Commonwealth which India would welcome. But, in so doing, it is necessary to discriminate between a mere synonym and a term which expresses concisely an idea not at present covered by a single word. There is no advantage in adopting such words as *shori* (leak), *uttar* (north), *sabzi* (vegetables), *pali* (silt), or *nuz* (flood), if, as the glossary indicates, these are the bare and exact meanings of the vernacular. In some cases, the glossary accepts spellings which are archaic; for instance, the use of the *h* in Burmah to indicate the open *a* sound has been long discontinued, and there is no good reason why the Burmese word *pinda* should be spelled *pindah*. If the authors admit the term *bar* as a useful equivalent for "the high land of a *doab* as distinct from the *khadir*," readers who need an explanation will look in vain for a definition of *doab* and it is rather much to expect them to guess that it means the whole territory between two streams.

In the Glossary of Technical Terms, for words, such as capillarity, which have well-established meanings in physics, it would have been better to take explanations from standard text-books. "Critical velocity" is listed and is given three separate meanings, such as Reynolds critical velocity, etc.; but "critical velocity" as a term has no place in a glossary. The mathematical significance of "critical" might have been explained, if necessary, but the critical velocities should have been listed under their appropriate qualifying heads as Reynolds, Kennedy's, and so on, thus referring them directly to the phenomena or hypotheses immediately relevant. "Grade" and "gradient" are listed as synonyms and then explained by three definitions; but "gradient" in engineering and mathematics has reference to a slope, while "grade," thanks largely to American usage, has come to mean a prepared surface. This is a useful separation of functions for two allied words and it is a disservice to introduce confusion by suggesting that the two words are synonyms.

The need for new terms in engineering and science is obvious, but to take old words and cramp them into new meanings is bad practice and should be discouraged, unless their older values have ceased to be current: "delta," for instance, has a recognised geophysical value and we deprecate the use of the same word to connote a rate of water-spread. When we consider the extreme care with which men like Faraday chose new words, and the debt that is owed to them for the composition of terms which do not overlap with old meanings, we must deplore the carelessness so evident in some recent works on science and technology, and which frequently results in confusion of thought. Precision in the use of words is a discipline which apparently the modern world is too impatient to endure. It is a strange feature of a so-called scientific age, which prides itself on precision tools, that it should have lost regard for precision in one of mankind's most valuable tools, human speech.

The third section of the book repeats from the first edition two outlines of notations for irrigation formulæ. The publication of these in the first edition was perhaps justified, but after seven years the Board should have been able to decide which of the alternatives is preferable. It may be argued by the compilers that criticism of the vernacular and technical terms was not their function; theirs but to record and explain the terms, whether correct or incorrect, necessary or unnecessary. With such a view we should disagree. The explanation of terms used by the writers of papers had to be recorded, but the Central Board of Control had both the opportunity and a certain responsibility to discourage ambiguous or duplicated terms by suitable criticism or type setting. They are the controlling authority; if they fail, *quis custodiet ipsos custodes?* Undoubtedly, the work has value, but it might easily have been made much more valuable.

Applied Heat Transmission. By PROFESSOR HERMAN J. STOEVER. London: McGraw-Hill Publishing Company, Limited. [Price 17*s.* 6*d.*]

A GREAT part of the work of engineers is concerned with either facilitating or impeding the flow of heat. The extent of the metallic surface that has to be provided in even a moderately sized power station for the transmission of heat amounts to many acres, while the surface through which the flow has to be stopped is of comparable magnitude. The laws of heat transmission are therefore of great importance to the designer, whose needs have been catered for in innumerable books. The author of the present volume follows the standard procedure by considering conduction, radiation and convection separately. He disposes of conduction in twenty pages and radiation in a further fourteen, the treatment in both cases being along the usual lines. The transmission of heat by convection, which is of much more general importance in engineering apparatus, is given another 76 pages. A short chapter on the calculation of pressure drop practically completes the theoretical portion of the book. The two remaining chapters are almost entirely descriptive, tables of conductivity and emissivity are given in an appendix.

The volume is intended, according to the preface, for both practising engineers and students. Its educational value to the latter, however, except in so far as some of the descriptive matter is concerned, is distinctly limited, for principles are less emphasised than formulæ. The fundamental work of Osborne Reynolds, who showed that the mechanism by which heat was conveyed from a fluid to a surface was identical with that by which the momentum of the fluid was destroyed, so that heat transmission must be intimately connected with resistance to flow, is quite ignored. The reader is confronted instead with a number of formulæ and logarithmic charts, to the accuracy or appropriateness of which he has little guidance except the indications of their source, given in footnotes. As regards the pressure drop in tubes, the treatment is similar. There is no mention of the Stanton-Lees formula, which gives with very great accuracy the resistance encountered by any fluid, whether gaseous or liquid, flowing along a smooth tube. The author prefers to rely on the ordinary hydraulic or Fanning equation containing a variable friction factor, for which another formula has to be used. The actual procedure to be followed in finding the pressure drop of fluids flowing turbulently through a straight smooth tube consists in first reading the "basic" pressure drop appropriate to the fluid from a logarithmic chart, and then multiplying this by two factors, one to correct for temperature and the other for tube diameter; the factors are obtained from tables. The result may be satisfactory, but the method is hardly instructive.

As will have been gathered, the book is one that is likely to make its greatest appeal to those who want to arrive quickly and easily at an answer to ordinary questions on heat transmission, and who are content to rely on the methods recommended. To such it may be useful, but its scope is somewhat limited; heat exchangers of the regenerative type, for example, are dismissed in a short paragraph. A chapter on insulation gives a good idea of the methods adopted by firms who specialise in such work.

AIR CONDITIONING OF INDIAN RAILWAY COACHES.

(*Continued from page* 174.)

In tropical climates, the steam-ejector type of refrigeration can be ruled out as uneconomical, so that the choice lies between mechanical refrigeration and ice-activation, either of which may prove more suitable than the other according to local conditions. Consideration must, however, be given to the fact that ice activation caters for cooling only, whereas the power supply to a mechanical air-conditioning plant can be adapted to provide cooling during hot weather and heating during cold weather. The only equitable basis of comparison for the two systems is a specified refrigeration demand, such as may be made for a particular service. This comparison the author proceeds to make, for a maximum daily demand of 4 tons of refrigeration and provision for electric heating in cold weather. The results of his analysis may be summarised, in anticipation, by stating that the air-conditioning plant, comprising ice-activated cooling and electric heating, is the more costly. The electro-mechanical compression system is the more economical if operating conditions are such that the average load factor is close upon 60 per cent. throughout at least six months in the year. If, however, it is sufficient to have summer cooling only during five months or less, the ice-activated system may prove the less costly.

In order to indicate these economic aspects with sufficient accuracy to serve as a guide for the solution of specific problems, the author proceeds first to estimate the load upon the air-cooling plant installed in an Indian State Railway coach. The overall dimensions of the coach are 68 ft. long, 10 ft. wide and 8 ft. mean height, giving a clear internal volume, exclusive of partitions and furniture, of 4,800 cub. ft. Since the number of passengers is only 14, to which may be added one attendant, it is probable that the coach is equipped with sleeping accommodation and intended for night and day travel, somewhat on the lines described in the *Railway Gazette* article referred to on page 174, *ante*. The floor and roof areas are 680 sq. ft. and 800 sq. ft., respectively, the end walls 80 sq. ft. each, and the total side-wall area amounts to 965 sq. ft., of which 185 sq. ft. is occupied by windows, leaving an unglazed side-wall area of 780 sq. ft.

The order of temperature conditions to be met is given in Table I.

TABLE I.—*Typical Temperature Conditions.*

	Bombay.		Delhi.
	Summer.	Monsoon.	Summer.
External air, dry-bulb temp. (deg. F.)	95	85	115
External air, relative humidity (per cent.)	60	80	20
External air, moisture content (grains per lb.)	150	146	90
External air, total heat content (B.Th.U. per lb.)	46·75		
Internal air, dry-bulb temp. (deg. F.)	76	74	80
Internal air, relative humidity (per cent.)	65	68	40
Internal air, moisture content (grains per lb.)	85	86	61
Internal air, total heat content (B.Th.U. per lb.)	32·25		

It may be remarked that the inside dry-bulb temperatures tabulated are derived from the formula mentioned earlier, namely:

$$72 + \frac{1}{6}\,(\text{outside dry-bulb temperature} - 72).$$

The relative humidity inside is obtained by reference to the recommended "comfort zone," while the moisture and total heat contents are taken from psychometric tables.

If the train service under consideration is, for example, between Bombay and Delhi, the heat load should be computed for each of the different sets of conditions in order to ascertain the capacity of plant needed to meet the maximum load. Merely to exemplify the method adopted, however, it suffices to make the calculations for only one set of conditions, those for Bombay in summer being chosen. Within the desired accuracy of estimation, changes in the physical properties of air due to temperature may be neglected. Thus, air density may be taken as 0·07 lb. per cubic foot, specific volume as 14 cub. ft. per pound and specific heat as 0·24. If, therefore, the allowance of fresh air is taken to be 27 cub. ft. per minute for each occupant of the coach, the heat load due to the input of make-up air is proportional to the change in total heat and is given by $27 \times 15 \times 60 \times 0{\cdot}07\,(46{\cdot}75 - 32{\cdot}25) = 24{,}700$ B.Th.U. per hour.

It may be noted that the fresh air input of 24,300 cub. ft. per hour, adopted by the author, corresponds to $\frac{24{,}300}{4{,}800} = 5$ volume changes per hour, which is a generous allowance, 2 changes per hour being the desirable minimum.

The heat leakage through the roof, walls, floor and windows of the coach is given by the product of area, temperature difference, and an overall coefficient of heat transmission, U. This coefficient is regarded by the author as the reciprocal of a resistance coefficient R, evaluated from the separate properties and thicknesses of the various materials of which the partition is composed, account being taken of the effective thermal transmission of the air films adjacent to the internal and external surfaces. Symbolically, the general expression for the overall transmission of a composite partition is —

$$U = \frac{1}{R} = \frac{1}{1/f_1 + 1/f_0 + 1/a + \Sigma\, X/K}$$

where f_1 and f_0 = conductivity of inside and outside surfaces, respectively; a = conductivity of air in a still air space; and K and X, respectively = the conductivity and the thickness of the structural or insulating material. Values of K for materials used in the construction of air-conditioned passenger coaches, quoted in the paper, are collected for reference in Table II, herewith.

TABLE II.—*Comparative Thermal Conductivity of Insulating Materials.*

Material.	Thermal Conductivity K. B.Th.U. per sq. ft. per in. per deg. F. per hour.
Asbestos (sprayed)	0·25
Aluminium foil	0·29
Celotex (sugar-cane fibre board)	0·33
Cork, slab or boards	0·30
Wood-pulp board	0·34
Cotton (seed hulls)	0·31
Dry Zero (ceiba fibres, batted)	0·25
Hair felt (cross fibres)	0·26
Kapok (loosely packed)	0·24
Wood (average)	1·0
Teak	1·13
Glass	5·0
Floor composition (linoleum)	5·0
Outside air film (20 m.p.h. and over)	3·5
Inside air film (20 m.p.h. and over)	1·6
Still air space (¼ in. wide and over)	0·67
Steel	320·0

Based on these data, combined with the details of the construction, the computation of heat leakages through the fabric of the coach may be exemplified as shown in Table III.

TABLE III.—*Heat Leakages.*

	Thermal Resistance.
Roof (800 sq. ft.):	
Outside air film (1/3·5)	0·29
⅛ in. Ruberoid covering (0·0625/5)	0·01
¾ in. teak roof boards (0·75/1·13)	0·66
½ in. sprayed asbestos (0·5/0·25)	2·00
Aluminium foil (0·016/0·29)	0·055
2 in. air gap between aluminium foils (1/0·67)	1·48
Aluminium foil	0·055
½ in. sprayed asbestos	2·00
2-mm. "Limpet" sheet (0·1/0·3)	0·33
Inside air film (1/1·6)	0·63
Overall resistance coefficient R	7·51
Heat leakage through roof. B.Th.U. per deg. F. per hour $\left(\frac{800}{7{\cdot}51}\right)$	106

A similar analysis for the floor, composed of 1-in. thickness of sprayed asbestos between two layers of 1-in. teak boards, plus an internal rubber flooring ⅛ in. thick, leads to a value of 100 B.Th.U. per deg. F. per hour for the heat leakage through the floor.

The side walls call for separate treatment according to whether the structural wall or the windows are in question. The former consist of an outside steel panel ⅛ in. thick, on which is sprayed a 1-in. thickness of asbestos. This insulation is separated from a layer of ½-in. teak boards by an air gap 3½ in. wide, bounded on each side by a sheet of aluminium foil. Within the teak boarding is a ½-in. layer of Thermotex board having a final, internal decorative cover of Rexine. Analysed on the same lines as the roof, the 780 sq. ft. of side-wall area (exclusive of windows) have a heat leakage of 100 B.Th.U. per deg. F. per hour. The windows comprise two ¼ in. sheets of glass separated by a 1-in. air gap. On one side of the coach they are regarded as being in the shade, and the heat leakage through the area of 92·5 sq. ft. so affected is at the rate of 40 B.Th.U. per deg. F. per hour.

On the other side of the coach, the criterion of heat transmission is solar radiation which, on windows, may be taken as having a maximum value of 285 B.Th.U. per square foot per hour. Of this amount, however, only from 50 per cent. to 60 per cent. passes through the glass, the remainder being dissipated by reflection and radiation outwards from the glass surfaces. Further, the solar heat passing through the windows is proportional to the sine of the angle between the sun and the zenith. Under Bombay summer conditions, this angle is 15 deg. and its sine is 0·26. Hence the solar heat passing through the windows on the sunny side of the coach $= 285 \times 0{\cdot}26 \times 0{\cdot}55$, say, 40 B.Th.U. per deg. F. per hour per square foot. It is noteworthy that this rate per square foot is the same as that for the entire window area on the shady side; in other words, the transmission due to Indian solar radiation through windows, even with the sun so near the zenith, is nearly a hundred times that due to thermal conductivity through the shaded windows. Solar radiation is also an important factor in transmitting heat through the roof and through the structural wall on one side of the coach, its effect being modified by the nature of the external surfaces. For the roof, covered with Ruberoid, solar radiation may be taken as equivalent to 40 deg. F. additional external temperature; while for the red-painted external side walls the figure is 25 deg. F.

As regards the end walls, the arrangement of the ventilating system is such that cool air is exhausted through the lavatories at the ends of the coach, and the heat leakage to compartments is therefore negligible. Allowance may, however, be thought desirable for the leakage through the corridor at one end, Mr. Saksena's estimate for this quantity being 225 B.Th.U. per hour. Additional sources of heat input to the coach are the bodies of its occupants and the heat dissipated by electrical apparatus. For a person at rest, the emission is approximately 410 B.Th.U. per hour, made up of 270 B.Th.U. and 140 B.Th.U. per hour, respectively associated with the sensible heat of a warm body and the latent heat due to perspiration. Thus,

TABLE IV.—*Total Heat Load.*

	B.Th.U. per Hour.
By conductivity through roof, walls and floor $19 \times (106 \quad 100 + 100 \quad 40)$	6,574
Leakage through end of coach and corridor	225
Solar radiation through roof, 40×106	4,240
Solar radiation through wall on one side, $25 \times (100/2)$	1,250
Solar radiation through windows on one side, $40 \times (185/2)$	3,700
Passengers, 14×410	5,740
Attendant, 1×690	690
Fan motor	1,900
Fresh air input	24,700
Total (round figure)	49,000

the heat gain from 14 passengers amounts to 5,740 B.Th.U. per hour. The coach has one attendant, engaged in light physical exertion, from whom the heat gain may be taken as 690 B.Th.U. per hour. From the fan motor, delivering 0·6 shaft horse-power at an assumed efficiency of 80 per cent., the heat input may be simply computed to be 1,900 B.Th.U. per hour.

The total heat load for the stipulated temperature difference of $(95 - 76) = 19$ deg. F. may therefore be summarised as in Table IV, above. Since

1 ton of refrigeration is equivalent to the latent heat of fusion of 2,000 lb. of water ice, *i.e.*, 288,000 B.Th.U., and since refrigerating machines are rated in tons of refrigeration per day of 24 hours, the heat load on the coach demands a machine of approximately 4 tons rating.

By a similar, though somewhat simpler, analysis, since solar radiation and the body heat of passengers at rest are disregarded, the cold load during the heating season may be computed. The assumed winter temperature conditions are an internal temperature of 67 deg. F. and an external temperature of 45 deg. F. The heating demand is as follows :—

	B.Th.U. per hour.
By input of 400 cub. ft. per minute of fresh air	9,200
Conductivity through roof, floor, walls and windows	8,500
Allowance for additional air leakage ...	300
Gross total	18,000
Deduct heat from fan motor and body-heat of attendant	2,300
Net cold load	15,700

To meet this demand, the artificial heating supply (assumed to be electrical) has a capacity of $\frac{15,700}{3,400} = 4{\cdot}6$ kilowatts. The nominal requirement, therefore, is a 5-kW generator with batteries of corresponding size.

(To be continued.)

AMERICAN SOCIETY FOR TESTING MATERIALS.

We continue below our brief summaries of the more important reports and technical papers presented during the course of the 44th annual meeting of the American Society for Testing Materials, held in Chicago from June 23 to 27. We commenced to print these abstracts on page 186, *ante*, and gave a general account of the meeting on page 154, *ante*.

Non-Ferrous Metals and Alloys.

Two sessions were held to discuss questions relating to the properties and applications of non-ferrous metals and alloys, and, at one of them, problems connected with the corrosion of these materials were also dealt with. Of special interest was a paper on "The Properties of Certain Lead-Base Bearing Alloys," by Messrs. A. J. Phillips, A. A. Smith and P. A. Beck. This contained data on a new lead-base alloy containing 12·5 per cent. of antimony, 3 per cent. of arsenic, and 0·75 per cent. of tin. The authors stated that, at elevated temperatures approximating to those prevailing in internal-combustion engine bearings, the tensile strength and Brinell hardness of the new alloy were considerably higher than those of the standard lead-base bearing alloys and equal to those of the tin-base alloys. In addition, the new material retained its higher hardness over long periods of exposure at elevated temperatures, whereas the standard alloys showed considerable softening under such conditions. The new alloy had been used in a number of motor cars and machines, and in some cases trials had been run for periods of upwards of 18 months. There had been no failures so far, and it was felt that these practical trials afforded reasonable confirmation of the results anticipated from the laboratory tests. In his paper on the "Comparative Value of Arsenic, Antimony and Phosphorus in Preventing Dezincification," Mr. W. Lynes stated that laboratory tests on 70-30 and Admiralty brasses had confirmed that the dezincification of alpha-brass alloys could be effectively suppressed by a small addition, of the order of 0·03 per cent., of arsenic, antimony or phosphorus, without impairing the properties of the alloys.

Three papers dealing with methods of finishing were appended to the Report of Committee B-6 on die-cast metals and alloys. In the first, entitled "Finishes for Aluminium Die Castings," the authors, Messrs. A. E. Keskulla and J. D. Edwards, stated that aluminium die castings were covered with a thin transparent oxide film which constituted one of their most important advantages from a service standpoint. For numerous applications, the ability of aluminium alloys to form and maintain this natural film was sufficient protection, and further finishing was not necessary. For other applications, however, where a more decorative appearance or better resistance to service conditions might be desirable, a wide assortment of durable and attractive finishes were available, comprising mechanical, chemical, anodic, electroplated and painted finishes. In the second paper, "Finishing Magnesium Die Castings," Mr. H. W. Schmidt stated that magnesium die castings left to mild atmospheric weathering gradually acquired a layer of oxide, hydroxide or carbonate which protected them from further attack. For most applications, however, the parts should be finished in some manner and the method adopted, whether chemical or organic, depended on the requirements to be met. Mr. E. A. Anderson, who dealt with "The Finishing of Zinc-Alloy Die Castings," stated that plated metallic, plated non-metallic, immersion non-metallic and organic finishes could be used for the decoration or the protection of zinc-alloy die castings.

The first report of Committee B-8 on electro-deposited metallic coatings, which committee was formally organised last spring, included two proposed new standard specifications for electro-deposited coatings of nickel and chromium on copper and copper-base alloys, and similar coatings on zinc and zinc-base alloys. The first specification provided for three types of coating, in each of which the minimum thickness of the chromium deposit was the same, namely, 0·00001 in., while the minimum thicknesses of the nickel coating were 0·0005 in., 0·0003 in., and 0·0001 in., respectively. The requirements of the second specification were similar, but a preliminary copper coating was prescribed. In this specification the salt-spray test was employed to determine the continuity of the coatings, and it was laid down that they must not show appreciable corrosion after exposures of 48, 32 and 16 hours, respectively. The question of season cracking was dealt with in several papers, one of which, by Mr. H. P. Croft, was entitled "Influence of Combined External and Internal Stresses on the Tendency to Stress Corrosion Cracking of Cartridge Brass." This paper showed that the tendency to cracking depended not only upon the degree, but on the type of cold work. The author stated that, in the case of cold-drawn wires, this tendency reached a maximum after a certain degree of reduction, which, however, was not paralleled in wires cold-worked by other means. Moreover, the observations of a previous investigator that the influence of grain size in annealed metal persisted through any subsequent cold-working operation, and even through the subsequent low-temperature stress-relief annealing, was confirmed.

Plastics.

Recent progress made in plastics was evident from a number of papers discussing the properties of, or methods of testing, these materials. An investigation by Mr. W. N. Findley, described in a paper entitled "Mechanical Tests of Cellulose Acetate," was undertaken owing to the fact that relatively few data are available on the load-resisting properties of plastics. The tests carried out consisted of short-time tensile tests using an extensometer, long-time constant load (time-to-fracture) tensile tests, and vibratory bending fatigue tests of notched and unnotched specimens. The author found that the upper yield point, the lower yield point and the fracture stress all increased with increasing speed of testing until a critical speed was reached at about 1·5 in. to 2 in. per minute, beyond which these values remained substantially constant. An examination of these data indicated that the values of the lower yield point were more consistent, as shown by less "scatter" in the results, than either the upper yield point or the fracture stress. Incidentally, the lower yield point was readily determined, at any testing machine speed, with any machine on which the load was self-indicating. In the endurance tests it had been found that with cellulose acetate, as with other materials, the shape of the specimen seemed to have a distinct effect upon the endurance limit under repeated stresses.

Mr. J. Delmonte discussed "The Shear Strength of Moulded Plastic Materials." He pointed out that a shear-strength determination afforded a simple and rapid method of comparing an important physical property of these materials. Using a punch and die of standard design, tests could be performed in a few seconds and these were quite accurate when carried out with the proper load-measuring equipment. One purpose of the present investigation had been to develop a technique which would enable moulders to determine the physical quality of their moulded samples at short notice, without having to wait for the carrying out of the more conventional compression and tensile tests.

Petroleum.

An important and far-reaching report was submitted by the Society's Committee D-2, on Petroleum Products and Lubricants. One of the functions of this committee is the standardisation of test procedures for various properties of petroleum products, and several of the new tentative standard specifications developed by the committee provide such tests. These specifications relate, among other matters, to tests for the ignition quality of Diesel fuels, and for the knock characteristics of aviation fuels. The test intended for the determination of the ignition quality of Diesel fuels does no in terms of an arbitrary scale of A.S.T.M. cetane numbers. The A.S.T.M. cetane number of a Diesel fuel is defined by, and is numerically equal to, the percentage, by volume, of cetane in a mixture of cetane and α-methylnaphthalene which the fuel matches in ignition quality when compared by a prescribed method. Thus, by definition, α-methylnaphthalene has a cetane number rating of zero, and cetane one of 100. The cetane value is reported to the nearest whole number.

The test for the knock characteristics of aviation fuels, for use in aircraft engines of the spark-ignition type, differs from the method of testing the knock characteristics of motor fuels (Specification D 357) principally in the manner in which the combustion characteristics are measured. In the new method a thermal plug is employed for comparing temperatures in the cylinder, while in the motor-fuel method, knock intensity is measured by a bouncing pin and knock-meter. The term, knock characteristics, however, has been retained on account of its widespread use, even though knock intensity is not actually measured. The A.S.T.M. knock value of an aviation fuel is given as the whole number nearest to the percentage, by volume, of iso-octane (2, 2, 4-trimethylpentane) in a blend of iso-octane and normal heptane which the fuel matches, in knock characteristics, when compared by the prescribed method. It was emphasised, at the meeting, that these specifications do not constitute a definition of aviation spirit; neither do they include all types of fuel satisfactory for spark-ignition aero-engines. Certain equipment or conditions of use may require fuels having special characteristics. Three grades of aviation spirit, however, are provided for. These vary chiefly in the matter of knock value and the grades are designated by their respective A.S.T.M. aviation-spirit knock values, namely, Grade 73, Grade 91 and Grade 100.

In a paper on "Performance Specifications for Greases," Messrs. R. C. Adams and H. E. Patten described special testing equipment and methods developed at the U.S. Naval Engineering Station. Plasticity, leakage, "bleeding," and resistance to oxidation, the authors stated, had been measured under accelerated or simulated service conditions and the specification requirements based upon the results obtained instead of upon the composition of the lubricant. In the applications for which the performance specifications had been developed monetary considerations were relatively unimportant; less than 1 lb. of grease would be required for all the control bearings of a large bombing or transport aeroplane. Hence, the primary consideration was not the cost of the grease but whether it would provide satisfactory lubrication under all service conditions.

WELDING ELECTRODE FOR NICKEL-CHROMIUM STEELS.

The manufacture of specially prepared electrodes has made possible the welding of the high nickel-chromium steels, and, among the more recently introduced electrodes of this type is known as Nicrex, made by Messrs. Murex Welding Processes, Limited, Waltham Cross, Herts. The weld metal deposited by this electrode, it is stated, contains high proportions of nickel and chromium which are carefully balanced to combine resistance both to corrosion and to the effects of high temperature. The deposit is further claimed to be ductile and free from porosity, to possess high mechanical properties, and to be capable of forming a true junction with nearly all carbon and alloy steels. This last is a particularly useful property as it is often necessary to weld nickel-chromium steel to mild steel and in such cases difficulties may occur owing to brittleness on the weld zone. We understand that the new electrode has given entire satisfaction in a number of instances of this type, such as the welding of non-magnetic inserts into mild-steel switch-box cases and other electrical equipment; the building up of corrosion-resisting pads on the joint faces of chemical plant; the repair of corrosion wastage in hydraulic machinery; and the building up of furnace parts wasted by oxidation. It is emphasised that the amount of interfusion at the joint, with resultant dilution of the weld metal, is small, hence there is no danger of the corrosion resistance or heat resistance of the deposit being impaired by the composition of the steel on which it is deposited. A case is cited in which a pad of weld metal deposited by the new electrode has been superimposed on the end of a steel tube and machined into a joint face. This, it is stated, was afterwards subjected to an operating pressure of several thousand pounds per square inch, under corrosive conditions. An examination made after several months' service gave no indication of any leakage or deterioration. It is pointed out that, owing to the high electrical resistance of Nicrex core wire, the amperage of the welding current must be controlled within close limits.

THE NESFIELD DEANE STOKER FOR WOOD-WASTE FIRING.

MESSRS. FISHER DEANE ENGINEERING COMPANY, LIMITED, LONDON.

Fig. 1.

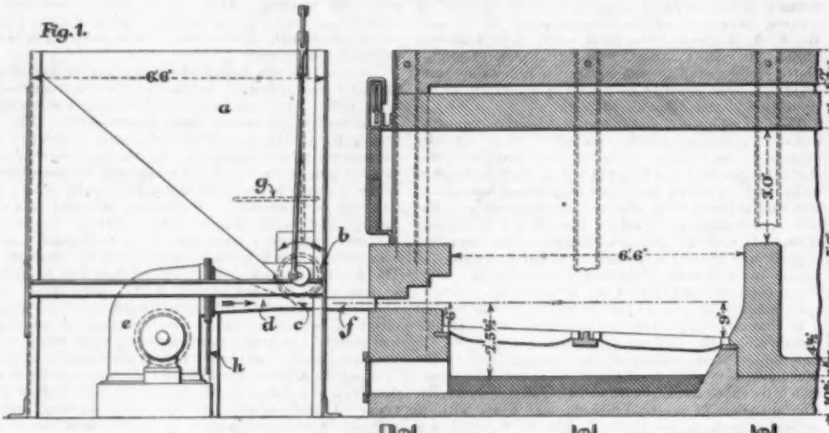


Fig. 2.

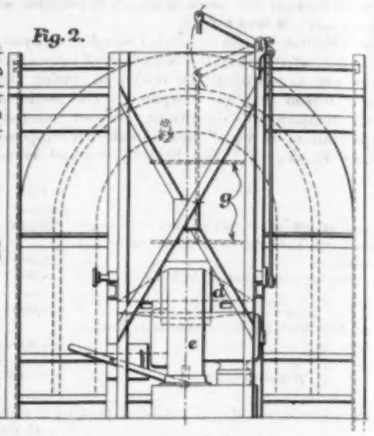
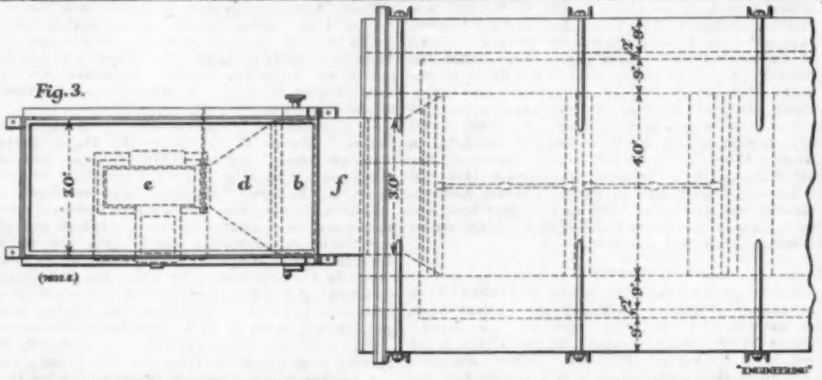


Fig. 3.



FURNACES FOR BURNING SAWDUST AND OTHER REFUSE FUELS.

Of the wide variety of possible fuels for steam-raising, several present greater combustion difficulties than do the more commonly-used coal, oil and gas. Power and heat in considerable quantities, however, can be obtained from waste substances, such as wood shavings and sawdust, cotton-seed husks, rice husks, flax shives, etc. These materials being bulky and generally of little or no commercial value, where they are produced, have to be disposed of in some way, usually by burning, and it is obvious that if the heat developed during combustion can be utilised, valuable economies may be secured. The bulkiness and light weight, however, give rise to the combustion difficulties referred to above. For example, in the well-known step-grate, if the chimney draught is not strong enough the material merely lies on the steps and chars, while if it is too strong the fuel is either drawn up the chimney only partly consumed or collects in the flues in a manner analogous to the accumulation of snowdrifts. Often the furnace arrangement is so sensitive that a slight change in the atmospheric conditions is sufficient to interfere with the combustion.

Apparatus for consuming fuels of the nature indicated above has been developed from time to time, and examples of it have been dealt with in these columns. One of the latest designs of such apparatus is described below. It has been developed by Messrs. Fisher Deane Engineering Company, Limited, 17, Victoria-street, Westminster, London, S.W.1. The characteristic features of the design are that the fuel is positively fed into an air stream, adjustable in both volume and velocity, and the fuel-laden air is directed against a baffle which sets up the turbulence necessary to maintain the fuel particles suspended in the combustion chamber and thus individually surrounded by an oxidising atmosphere. The apparatus, which is known as the Nesfield Deane stoker, is usually fitted either to a combustion chamber, the gases from which pass through a boiler, in installations where the resultant steam can be economically utilised; or to a combustion chamber from which the gases escape to a chimney stack, this latter arrangement being adopted in installations in which the primary object is to dispose of the waste material, its potential steam-raising capacity being neglected. In both types of installation the combustion chamber contains firebars on which a proportion of the combustion takes place. The steam-raising type of equipment is illustrated in Fig. 1 to 3, on this page, and the destructor type in Figs. 4 to 9, opposite, but it should be understood that neither of these lay-outs is invariable, each installation being designed to suit the particular material to be burnt.

The illustrations, Figs. 1 to 3, however, are sufficiently typical to show the main characteristics of the stoker. The standard unit has an average feeding capacity of 1½ tons of wood shavings per hour and up to 10 per cent. of sawdust can be consumed at the same time. The stoker proper consists of a hopper *a* in which the material collected from the woodworking machines is deposited, generally by means of a cyclone exhausting system. As will be seen, the hopper tapers towards the feed drum *b*. This rotates in the direction indicated at a speed of from 3 r.p.m. to 12 r.p.m., according to conditions and has its periphery furnished with projecting studs. The hopper in the vicinity of the drum has an adjustable lip *c*, which forms part of the top of the discharge duct *d* from the fan *e*. The studs on the drum discharge the material into the air stream from the fan, the direction of which is indicated by an arrow. The stream flowing past the adjustable lip creates a suction effect on the lower surface of the drum, which causes the material to be picked up and carried by the air stream into the furnace through the burner *f*, which is simply a prolongation of the duct *d*, and, though shallow in depth, is nearly the same width as the furnace.

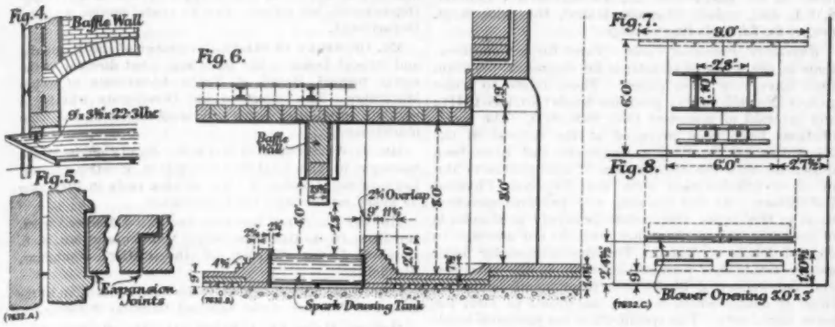
As the material may have a tendency to form arches in the hopper, with consequent interruption of its movement towards the drum, an agitating device *g* is provided. This consists of a rod having three cross bars, one projecting into the mass of material and the other two lying parallel to the end wall of the hopper above the drum. The agitator is given a reciprocating movement by means of a small crank on the drum shaft and a lever system. The arrangement will be clear from Figs. 1 and 2. To prevent damage to the drum from pieces of wood too large to pass it, a spring-loaded trap is provided by which such pieces are intercepted and diverted. A sliding door at each side of the hopper at the bottom gives access to the ends of the drum. The drum is driven by a motor through variable-speed gear, which, however, are not shown in the illustrations. The fan is also driven by a motor either directly, as shown, or by means of a belt. The fan delivery naturally varies with the size of the plant, the capacity of which is governed by the air speed in conjunction with the drum speed. A suitable fan for a furnace of the design and dimensions given in Figs. 1 to 3 would be one 12½ in. in diameter, with a discharge capacity of 2,000 cub. ft. of air per minute at a pressure of 1½ in. water gauge. A sliding damper *h* is inserted between the fan discharge branch and the tapered duct *d*, and is actuated by the lever, with quadrant slot adjustment, seen in Fig. 2.

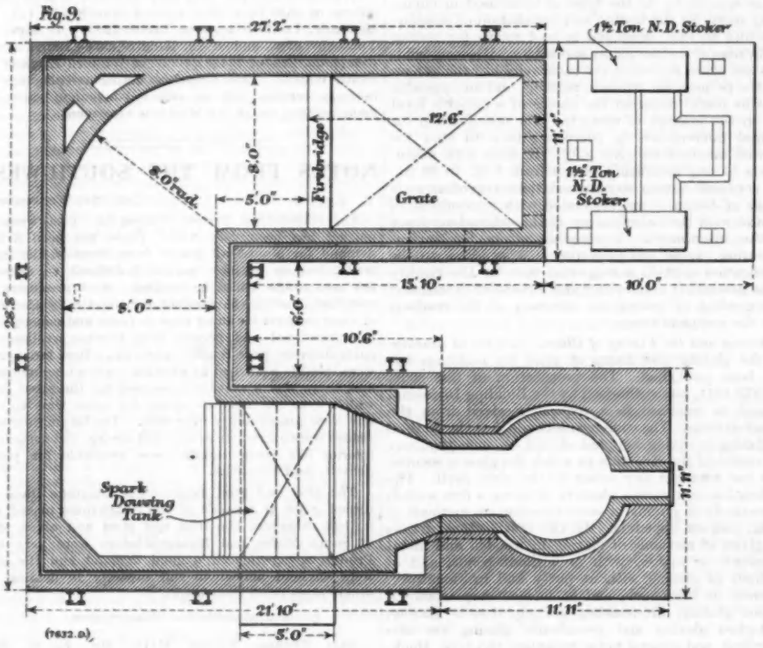
The construction of the furnace is so evident from the figures as to require little comment. It consists of a shell of ordinary brick enclosing a furnace of firebrick, there being an airspace between the two. Lateral strength is provided by buckstays pitched at 4-ft. centres. The front wall, in which is the slot for the burner, is formed, is of firebrick, as also is the back bridge. The bottom of the furnace is lined with refractory material above the base of ordinary brick. It will be noted that the centre line of the air and fuel stream is well below the top of the back bridge, a high degree of turbulence being set up by the impingement of the stream on the bridge. The lighter particles of the fuel are retained in the eddies and completely burned in the air, the heavier particles falling to the firebars on which they are burnt, a secondary stream of air being admitted through a pair of doors with adjustable louvres below the firebars. The firebars, as shown in Fig. 3, are of the type normally used for coal-burning though the air spaces are narrower than is usual for coal. Actually, however, this type of bar is comparatively little used in the Nesfield Deane stoker, the more common type consisting of bars of channel cross-section 6½ in. wide. These are fitted side by side with the flanges downwards. The flat top thus presented is perforated with closely-pitched conical holes, ½ in. in diameter on the underside and ¼ in. in diameter at the upper surface. The metal of the bars is ⅝ in. thick. Access to the furnace is provided by a pair of doors lined with refractory tiles and suspended by rollers running on a cross rail. A sight hole and cover is provided in one of the doors, and there is a pair of sight holes, with sliding covers, on the sides of the air duct. It is stated that combustion is completed within 15 ft. from the burner mouth and the gases generated have a high temperature so that they are effective for steam generation in whatever type of boiler may be fitted.

The example of an installation for the destruction of waste without recovering any heat from its combustion given in Figs. 4 to 9, employs two Nesfield Deane units, each being capable of burning 1½ tons of wood shavings and sawdust per hour, the material having an average weight of 6 lb. per cubic foot, as delivered to the hoppers. The situation of the firing units is indicated in Fig. 9, from which it will be clear that the combustion chamber is formed with two right-angle bends and that it terminates in a chimney stack. The firing units are, generally, of the type described above and discharge above a single large grate as shown in Fig. 8. The burner openings are 3 ft. wide by 3 in. deep, and the firebars are of the perforated type described above. There are, further, as seen in Figs. 7 and 9, side doors to the grate for the occasional insertion of large waste. The combus-

DESTRUCTOR FOR WOOD-WASTE.

MESSRS. FISHER DEANE ENGINEERING COMPANY, LIMITED, LONDON.





tion chamber, etc., is constructed, as in the other instance, with an outer shell of ordinary brick and an inner lining of firebrick, an air space separating the two walls. The walls are supported laterally by buck-stays consisting of 6 in. by 4½ in. rolled-steel joists arranged in pairs, as shown in Fig. 9, opposing pairs being coupled by tie rods between the joists and passing through dogs spanning them. The roof is of the suspended type, as may be inferred from Fig. 6.

The course of the gases of combustion from the grate to the chimney can be readily followed in Fig. 9, but it will be realised that, since there is no boiler to extract the heat from the gases and thus to extinguish incandescent particles, other means must be adopted which have approximately the same functions. The combustion chamber is, therefore, long and spacious and is restricted in cross section by a baffle wall, below which is a wide bridge containing a water tank. This construction is seen in Figs. 4, 6 and 9, the name "spark dowsing tank" applied to it in the two latter figures, indicating its function of extinguishing incandescent particles which are deflected downwards by the baffle wall above it. The tank is 18 in. deep and is formed at one end with a slope projecting outside the destructor. This slope is provided so that the wood ash which has settled in the water can be easily removed. The gas seal is formed by an inverted-channel section which dips into the water and carries the wall above it. The baffle wall is carried on an arch as shown in Fig. 4 and is provided with expansion joints as indicated in the part sectional plan, Fig. 5, this construction being necessary owing to the high temperature of the gases which ranges to 1,400 deg. C. to 1,500 deg. C.

Such a high temperature necessitates careful design of the destructor and selection of refractory material and it is stated that during the year and a half that the destructor illustrated in Figs. 4 to 9 has been working maintenance costs have been negligible. It might be noted, moreover, that the 3 tons of material per hour burnt in the destructor represents a surplus from the factory concerned, most of the waste from which is used for steam raising, the steam demand not being sufficient to justify the combustion under a boiler of the whole of the waste. Destruction of the surplus waste in a heap in the open is, of course, ruled out under present conditions and, in any case, is attended with considerable fire-risk to adjoining property while involving appreciable labour. Apart from the two examples dealt with above the Nesfield-Deane plant has been applied to installations combining the characteristics of both; that is, to installations having a boiler as well as a destructor, the gases being passed through the boiler when there is a demand for steam. Such a demand may be both irregular and intermittent, and in such cases a combination plant is very convenient.

ILLUMINATED SIGNS IN SHOP WINDOWS.—The Ministry of Home Security directs that, during black-out hours, shops must not have any lights visible from outside except certain permitted dimly-illuminated signs. The signs must be placed inside a ground-floor window or doorway and must not be conspicuous at a distance of 100 ft. The total illuminated area of all the letters and symbols must not exceed 144 sq. in., and all letters or symbols must be within a rectangular space not more than 3 ft. wide and 2 ft. high. The signs, which must be kept vertical, may only be illuminated for such time as the premises are open for business.

ELECTRICITY-SUPPLY STATISTICS.

THE annual report of the Central Electricity Board, which normally provides a useful guide to the progress of the electric supply industry, is not available for comment in the present circumstances. Similarly, the Annual Statistical Returns prepared by the Electricity Commissioners have not been published subsequent to those covering the period 1937-1938, ending on March 31, 1938. It has now been decided, however, that certain summarised figures for the year 1938-1939 may be made available and they were published at the end of last month. It is hoped that corresponding figures for the year 1939-1940 may be issued shortly, although a decision has not yet been reached regarding the information that can be given.

The summarised statistics for the year 1938-1939 which are now published do not extend into the war period and furnish no information either to the British public or our enemies regarding the effect of the war on electricity supply. They show increases in power-station capacity and units generated, but in this merely follow the trend of previous years and there is no striking development which might be attributed to the gathering of the war clouds. The figures show a total installed generating-plant capacity of 9,497,823 kW. This covers a net increase of 584,345kW over the year. Of this increase 32,859 kW represents direct-current plant, which may be taken to indicate that we are still some distance from the period when the whole country will be covered by the standard alternating-current system. The total number of consumers at the end of the period was 10,100,657, an increase of 7·94 per cent. The number of consumers taking a supply from public authorities was 6,767,742, showing an increase of 6·66 per cent.; the corresponding figures for the customers of companies were 3,332,915 and 10·61 per cent. The greater percentage increase in supply by companies may possibly be attributed to the growing tendency to establish works in small towns and country districts. The number of public-authority customers is, however, still more than double those of the supply companies.

The gross public supply for the year was 25,019,484,335 units, the corresponding figure for the previous year being 23,180,176,295 units. These gross figures include units generated under the direction of the Central Electricity Board, plus those generated independently by undertakers. They also cover a relatively small figure representing units purchased from outside companies and excess of inter-purchases over inter-sales. This latter item represents the difference between the returns of the purchasers and the returns of the sellers of bulk supplies. From the gross figure, it is necessary to deduct 1,365,295,182 units used on works, leaving a net public supply of 23,654,189,153 units, the corresponding figure for the previous year being 21,887,703,866. Of the total, 33·34 per cent. was employed for lighting, heating and cooking; 43·33 per cent. for power; 1·50 per cent. for public lighting; and 4·94 per cent. for traction. The main change in these percentages compared with the previous year is a relative rise in the lighting, heating and cooking load over the power load, showing the still increasing importance of the domestic demand. The units lost in transmission and distribution, and unaccounted for, represented 11·43 per cent.

The grand total of expenditure charged to capital account, at the end of the period for all authorised undertakers, including the Central Electricity Board, was 648,241,298*l.*, showing a rise of some 40,000,000*l.* in the year. Of the total, 27·75 per cent. was for generating plant, including land and buildings. This item increased by 9,000,000*l.* during the year. Main transmission accounted for 9·89 per cent., a rise of about 1,500,000*l.* Distribution at 48·59 per cent. showed a rise of some 20,000,000*l.* The relative percentages for generating equipment, against transmission and distribution added together, clearly illustrate the preponderating charge which the delivery of current represents as compared with its generation.

The total revenue of all authorised undertakers, including the Central Electricity Board, was 98,501,244*l.*, showing a rise of some 7,000,000*l.* over the previous year. The figure includes sales of energy, rentals of meters, apparatus, etc., work done for consumers and profit on the sales of fittings, but does not cover the excess of inter-sales of bulk supplies over inter-purchases. The total working expenses, excluding inter-purchases, were 53,953,302*l.*, a rise of 4,700,000*l.* Of the total, 72·94 per cent. represented working costs and 13·32 per cent. local rates. The cost of generation, excluding capital charges but covering generation independent of the Central Electricity Board, was 19,548,414*l.*, as compared with 17,489,068*l.* for 1937-1938. Fuel represented 75·87 per cent. of the total, salaries and wages 11·64 per cent., and repairs, maintenance and stores 12·49 per cent. The average cost per unit generated was 0·189*d.*, compared with 0·182*d.* for the earlier period, the rise being almost entirely due to the increased cost of fuel.

INSTITUTION ELECTIONS.

INSTITUTION OF MECHANICAL ENGINEERS.

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Associate Member to Member.—Frederick Alexander, South Farnborough; Frederick Laurance Atkin, Birmingham; Alfred Charles Barlow, Hayes, Middx.; Dudley James Barnard, Barking; Major George Clement Malcolm Bone, R.E., York; Colonel Henry Stacpoole Briggs, O.B.E., R.E., London, S.W.11; Harold Gordon Campbell, Woking; Reginald John Cowey, London, S.E.18; William Campbell Crockatt, B.Sc. (Glas.), Glasgow; James Crone, Ottawa, Canada; Herbert Thomas Davey, London, W.3; William Henderson Denholm, Glasgow; Fred Dewhurst, London; James Ferguson, B.Sc., M.A., Hamilton, Lanarkshire; Alexander Black Findlay, Glasgow; Hal Gutteridge, London, S.W.1; Vernon Clavering Hardy, M.A. (Cantab.), London, W.C.2; Geoffrey Handley Hopewell, London, N.W.8; James Sandys Ker Inskip, M.A. (Cantab.), Gravesend; Lt.-Col. Stanley William Joslin, M.B.E., R.E., Chislehurst, Kent; Cecil George Langford, London, S.W.3; Camille Clare Sprankling Le Clair, Ealing; Norman John Murdoch McLeod, Wellington, N.Z.; Captain Charles Gooch Miller, R.A.S.C., Birmingham; Professor Graham Fernie Mucklow, D.Sc. (Manch.), Birmingham; John Humphrey Russell Nixon, Loughborough; Mark William Plumpton, London, N.W.10; Lazarus Serafim Polychroniadis, London, E.C.3; Major Brian Gordon Robbins, M.Sc. (*Eng.*) (Lond.), London, S.W.1; Arthur John Rowledge, M.B.E., F.R.S., Derby; William Ellison Sharples, Ipswich; Daniel Montagu Francis Sheryer, Egham; Henry Norman Shirley, Birmingham; Jean-Baptiste Octave Sneeden, Ph.D., B.Sc., Glasgow; Walter Septimus Stredwick, Bournemouth; William Henry Thomas, London, S.E.18; Samuel Richard Yates, Wirral, Cheshire.

Associate Member.—James Todd Anderson, Edinburgh; Charles Alfred Bandfield, London, E.14; William Blain, London, N.W.10; Harry Littleton Bray, London, S.E.18; Lieut. Douglas Charles Burton, R.A.O.C., Home Forces; Stanley Clarke, Jarrow; Sqdn.-Ldr. George Henry Currall, M.M., R.A.F., Marlow, Bucks; Archibald Andrew Henry Douglas, B.Sc. (Glas.), Glasgow; Albert James Doyle, London, S.E.24; Lieut. (E.) George Frederick Colin Ellum, R.N., c/o G.P.O., London, E.C.1; Herbert Farmer Evans, B.Sc. Tech. (Manch.), Ilford, Essex; Leofric Fenn, Bristol; Frank Edward Forsdike, Ipswich; Arthur George Gates, Liverpool; Albert Lambert Jean Ghaye, Leicester; Major Frederick Arthur Goodman, M.C., R.A.O.C., Fulmer, Bucks; Hubert Lewis Hammond, Norwich; William Samuel Henry Hodges, Exeter; Ernest George Holberry, Darlaston, Wednesbury, Staffs; Eric Sydney Hunt, Shrewsbury; Alexander Inglis, Dagenham Dock, Essex; Charles Daniell Martyn Keyworth, Leamington Spa; Captain Owen Stanley Lieberg, R.E., London, S.W.1; Norman Mear, Huddersfield; Cecil Herbert McGeorge, Manchester; James Millar McLean, Renfrew; Sydney Melville, Bradford; Philip Eric Millbourn, London, S.W.1; John Barclay Neil, Liverpool; John Paisley, Bedford; James Andrew Pannell, Oxford; Sydney John Patmore, London, S.W.1; Herbert Arthur Paxton, Manchester; Ronald Arthur Pearse, M.A. (Cantab.), Manchester; John Stanley Raine, B.Sc. (Durham), Hengoed, Glam.; John Johnston Robertson, Chislehurst, Kent; Patrick Joseph Roche, Dublin; Tom Salter, Worcester; Thomas Gibson Scott, Digboi, Upper Assam, India; Commander (E.) Charles Edward Simms, D.S.O., R.N., c/o Admiralty, Whitehall, London, S.W.1; Joseph Victor Steele, Liverpool; Richard Thomas Millington Toyn, Sheffield; George Edward Vandy, Bromley, Kent; Herbert Wheeldon, Manchester; Joseph Edwin White, Newcastle-upon-Tyne; Eric Osmond Wright, Birmingham.

DOMESTIC WATER CHARGES.—A circular letter has been sent by the Ministry of Health to all water-supply authorities and companies, announcing the Minister's decision that no further increases should be made in the charges to consumers for domestic water supplies (including metered supplies for such purposes) without previous consultation with the Ministry. This follows the arrangements already made with respect to supplies of electricity and gas for domestic consumption. Authorities and companies who may consider an increase to be necessary are now required to submit full particulars of their reasons for any proposed alteration in charges.

BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 3*d.* including postage.

Engineers' Precision Tools.—Three further specifications in the series of standards for engineers' precision tools have now been issued. These relate to feeler gauges (No. 957-1941); precision levels (No. 958-1941); and internal micrometers (No. 959-1941). The specifications have been prepared at the request of the Institution of Production Engineers and have been drawn up with the co-operation of manufacturers and in close collaboration with the National Physical Laboratory. As was the case with previous specifications in this series, they relate primarily to standards of accuracy and performance, and do not attempt to control details of design. The specification for feeler gauges establishes permissible errors in the thickness and parallelism of blades and recommends combinations of blades which may be assembled to form the most useful sets. The specification for precision levels relates specifically to the type of level used in engineering shops for the testing and installation of machine tools and to that employed in tool rooms for testing the flatness of surface plates and tables. Recommendations are given regarding the sensitivities of the gauges and the permissible errors in reading, and an appendix contains useful notes on the choice of a suitable level and on the manner of using it. The specification for internal micrometers is complementary to that for external micrometers (No. 870). It deals with micrometers having measuring ranges from 1 in. to 36 in., and contains certain recommendations regarding such details of design as are associated with convenience in use and with the maintenance of the original accuracy of the instrument. Permissible errors for various measuring ranges are prescribed. Appendices to the specification contain a suggested test for the rigidity of the assembled micrometer and a detailed description of a method of testing the accuracy of the readings over the complete range.

Glazing and the Fixing of Glass.—A code of practice for the glazing and fixing of glass for buildings has just been published. The preparation of this code, No. 973-1941, was authorised by the Building Divisional Council in response to a request received from the manufacturers. The code recommends that the method of glazing or fixing adopted should be such that any movement of the structure to which the glass is secured does not transmit any strain to the glass itself. The publication comprises a glossary of terms, a first section on methods of glazing, a second section on methods of fixing, and an appendix. In the first section, details are given of methods of glazing in wooden and metal casements or sashes, with or without beads, and of methods of glazing without putty and in stonework, concrete or brickwork, and in framed shop windows. Patent glazing, fire-resisting glazing, double glazing, bent-glass glazing and greenhouse glazing are also described, and general notes regarding the type, thickness and quality of the glass, sight sizes, width of the rebate, and other matters, are included. In Part 2 details are given of various methods of fixing glass, including mastic fixing, screw fixing and fixing by clips and cover strips. In the appendix there are notes relating to normal conditions governing glazing and fixing, for the guidance of the glazing contractor and the main contractor.

BOOKS RECEIVED.

Experiments Upon the Flow of Water in Pipes and Pipe Fittings, Made at Nashua, New Hampshire, June 28 to October 22, 1892. By JOHN R. FREEMAN. 29, West Thirty-Ninth-street, New York: The American Society of Mechanical Engineers.

Sixty-Year Index. The American Society of Mechanical Engineers' Technical Papers, 1880 to 1939. 29, West Thirty-Ninth-street, New York: The American Society of Mechanical Engineers.

United States Geological Survey. Water-Supply Paper No. 874. *Surface Water Supply of the United States, 1939. Part 4. St. Lawrence River Basin.* Washington: Superintendent of Documents. [Price 30 cents.]

Roads and Road Construction Year Book and Directory, 1941-42. London: The Carriers Publishing Company, Limited, 1, Bridge-place, Belgrave-road, Westminster, S.W.1. [Price 10*s.* 6*d.* net.]

Directory of Paper Makers of Great Britain and Ireland for 1941. London: Marchant Singer and Company, 326, High Holborn, W.C.1. [Price 6*s.* net.]

The Physical Examination of Metals. By DR. BRUCE CHALMERS and DR. A. G. QUARRELL. Volume II. *Electrical Methods.* London: Edward Arnold and Company. [Price 20*s.* net.]

PERSONAL.

DR. J. W. JENKIN, B.Sc., A.I.C., director of research, Messrs. Tube Investments, Limited, has been appointed adviser on steel tubes to the Ministry of Supply.

MR. A. J. HASTINGS, A.M.I.E.E., deputy engineer and manager to the Great Yarmouth Corporation Electricity Department, has retired after 43 years' service with the Department.

MR. GEOFFREY CUNLIFFE, a member of the Industrial and Export Council, has been appointed director of the newly formed Board of Trade Directorate of Office Machinery. The object of the Directorate will be to regulate supplies of home produced and imported office machinery.

MR. J. W. SPEIGHT, A.M.I.E.E., deputy engineer and manager to the Leyton Corporation Electric Supply, Leytonstone, London, E.11, is retiring early in 1942 after 39 years' service with the Corporation.

MR. W. W. WOOD has been re-elected Master Cutler, the HON. R. A. BALFOUR Senior Warden and MR. S. E. OSBORN Junior Warden of the Cutler's Company, Sheffield.

LORD STANHOPE has been reappointed chairman of the Board of Trustees of the National Maritime Museum.

MESSRS. MACROME, LIMITED, Alcester, Warwickshire, inform us that they have opened branches at 111, The Headrow, Leeds (telephone Leeds 22657), to serve the Yorkshire area, and at 15, King Square-avenue, Bristol (telephone Bristol 26489), to serve Western England and South Wales. These branches, acting as collection and delivery centres, will provide a convenient service to firms making use of the Macrome treatment.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—During the past week the market has been very firm. There has been a brisk demand for almost all grades from users in the inland trade, but as business was still difficult to negotiate few new orders could be booked. Most producers had sufficient business to account for practically the whole of their outputs for some time to come and consequently the occasional odd parcels that become available for early delivery were readily taken up. Best large grades were steadily absorbed by existing contract commitments and there was a sustained request for the sized grades which were not easy to secure for some time to come and were consequently very firm. The bituminous small grades were extremely scarce and strong, but some of the inferior dry steam smalls were available for prompt delivery and were dull.

The Iron and Steel Trade.—The tin-plate trade continued quiet as a result of the restrictions placed upon it, but otherwise the iron and steel and allied trades of South Wales and Monmouthshire were very busy. Producers experienced a good demand and the works were engaged almost to full capacity in dealing with orders already on their books.

OLD TIMBER WATER MAIN.—MR. F. S. SNOW, M.Inst.C.E., honorary librarian of the Institution of Structural Engineers, has presented to that Institution a portion of elm water main which was excavated from Piccadilly, London. The specimen, which is stated to be over 400 years old, has been placed in the library.

CONTROL OF FINISHED STEEL FOR BRITISH COLONIAL TERRITORY.—All Colonial commercial requirements of standardised iron and steel products (such as come within the scope of the First Schedule of the Control of Iron and Steel (No. 15) Order, 1941), which are submitted to Colonial Governments for the purpose of obtaining a Colonial import licence will, if approved by the local authorities, be taken as on Government account, and arrangements for supply will be made directly by the local Governments through the Colonial Supply Liaison in the United States. Provisional licences will continue to be issued in the Colonial territories for supplies of such specialised products as cannot be obtained in the United States. Examples of these products are (*a*) repair parts for British locomotives and other machines now in use; (*b*) special castings; and (*c*) British Standard screws, nuts, bolts, etc., in so far as no alternative products from the United States may be suitable. Orders for these, for the present, will continue to be placed through commercial channels in the United Kingdom. Applications should be sent to the Colonial Office, Whitehall, London, S.W.1., and should quote the number of the Colonial Import Licence. Firms having outstanding orders, for which Colonial Import Licences were granted before September 1, should submit their applications through the Colonial Office with as little delay as possible, in accordance with the procedure at present in force for supply from the United States or the United Kingdom. These arrangements in no way affect the shipment of any orders already authorised by the Board of Trade.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Greater pressure on the North of England producing plants has necessitated a still greater curtailment of the distribution of material for general commercial purposes. Manufacturers, however, expect to turn out sufficient tonnage for essential needs but state that still larger quantities of scrap are required. There is an abundance of most descriptions of raw materials and sources of scrap supply have not yet been drawn upon fully. Delivery licences for some commodities are issued fairly freely but a shortage of one or two descriptions of iron and steel necessitates the strict enforcement of the control of distribution regulations.

Cleveland Iron Trade.—Consumers of foundry iron have moderate stocks and, as ample supplies from other producing centres continue to reach the district, no effort is being made to increase the make of Cleveland pig. Delivery licences are readily granted and distribution is satisfactory. Business is mostly done directly between makers and consumers, but merchants, although still unable to obtain full supplies, state that more tonnage is passing through their hands. The official values of Cleveland pig remain at the level of No. 3 quality at 128*s.*, delivered to local buyers.

Basic Iron.—The fixed nominal price of basic iron remains at 120*s.* 6*d.* The output is sufficient for the heavy and increasing needs of the steelworks in the Tees-side area but provides no tonnage for use elsewhere.

Hematite.—The shortage of hematite continues to cause inconvenience, but the stringency is eased to some extent by the increasing substitution of refined iron by firms engaged on work in the execution of which the latter can be used in place of hematite. Conditions still preclude an enlargement of the production and allocations are restricted to deliveries for essential purposes. The stabilised quotations are at the equivalent of No. 1 grade of hematite at 138*s.* 6*d.*, delivered to North of England customers.

Foreign Ore.—Imports of foreign ores, with the exception of descriptions needed for the manufacture of hematite, are substantial and are fully equal to current requirements.

Blast-Furnace Coke.—Transactions in Durham blast-furnace coke are few, both buyers and sellers being disinclined to discuss new business. The fixed price of good medium qualities is 36*s.* 9*d.* f.o.r.

Manufactured Iron and Steel.—Stocks of semi-finished iron and steel at the re-rolling mills are substantial and the deliveries of local products have increased, but the consumption is extremely heavy and an early expansion in the demands on makers in this district is expected. Finished-iron firms would welcome more buying of light material and steel-sheet producers, although still busily employed, are booking few new orders. Makers of structural steel could deal with more work than they have on hand. The demand for ship, tank and boiler plates is undiminished and the urgent need for increased supplies of special alloy steels necessitates a further expansion in production. Parcels of railway material are rapidly taken up as they become distributable.

Scrap.—Unusually large parcels of scrap are passing into consumption but the demand is greater than ever, pressure being mostly for machinery metal, heavy cast iron and heavy steel.

CONTROL OF EXPORT OF STEEL AND ALUMINIUM GOODS.—The Board of Trade has issued an Order, entitled the Export of Goods (Control) (No. 31) Order, 1941 (S.R. & O. 1941, No. 1310 (price 1*d.*)). This prohibits, as from September 4, the export, except under licence, of door and window frames and casements manufactured wholly or mainly of iron or steel (including alloy steel) and of containers and rivets—including tubular rivets—and certain other articles manufactured wholly or mainly of aluminium or aluminium alloys.

TOUGHENED GLASS FOR HOT CABINETS.—The spread of the civic restaurant and the extension of works canteens has resulted in the installation of large numbers of steam-heated cabinets in which prepared food is kept hot. The tops of these cabinets have hitherto been made of steel and the amount of this metal thus used may, in a large installation, be very considerable. In order to reduce its consumption, the Board of Trade requested Messrs. Pilkington Brothers, Limited, St. Helens, to carry out tests with toughened-glass tops. These tests have proved the scheme to be practicable and it is now being used for the purpose above mentioned, with the advantages that it compares favourably in cost with the material released and admits light to the interior of the cabinet so that the food is visible and cleaning is facilitated. The cabinets normally operate at a temperature between 120 deg. F. and 150 deg. F. The new tops take slightly longer than steel to warm up, but the lower heat conductivity of glass tends to reduce heating costs.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The demand for steel is still increasing, but production is sufficient for requirements. The war industries are taking the bulk of the production, and only a limited tonnage is available for commercial customers. Despite the record demand for raw and semi-finished materials, producers are able to obtain adequate supplies of pig iron, hematite and scrap. Alloys are also in fair supply. Intense activity persists in the heavy machinery and engineering trades. Steelworks and ironworks machinery and related equipment are in strong demand, and some of the large firms have important orders on hand. These include rolling-mill plant, strip mills, heavy hydraulic presses, sheet mills, roll lathes, hot saws, shell-forging presses, hydraulic pumps, and steam hammers. Shipbuilding requirements are increasing. Large quantities of forgings and castings, turbine parts, auxiliary machinery and deck furnishings are leaving works in this area for shipyards in various parts of the country. Railway rolling stock is in steady demand. There is an improved call for all types of electrical plant, and large quantities of Sheffield-made steels are being sent to firms specialising in the production of generators, transformers, switchgear, and similar plant. In addition, hollow-forged boiler drums are in demand in connection with power-station extension schemes. Sheffield makers of agricultural machinery parts and implements have had a successful season; the overseas requirements are better than they were a year ago. More encouraging reports are to hand from the tool-making branches, in which outputs are increasing. Engineers' small tools are in exceptionally strong demand; twist drills, milling cutters, machine knives, hacksaws and blades, and precision tools are being ordered freely. Machine tools are also in strong demand.

South Yorkshire Coal Trade.—Larger tonnages of coal are moving from pits in this area; steelworks and ironworks are taking large quantities. Steams are in strong demand, and smalls and slacks are finding a ready market, the bulk of the output going to electric power stations and gasworks. Railway companies are taking larger quantities of locomotive fuel, and are building up reserves. Foundry and furnace coke are steady, and central-heating coke is in stronger demand.

UNITED STATES COLLIERY INDUSTRY.—During the week ended August 30, the average daily production of bituminous coal in the United States was 1,817,000 tons, compared with 1,792,000 tons in the preceding week and 1,517,000 tons in the corresponding week of 1940.

COLLECTION OF SCRAP BY THE POST OFFICE.—During the last two years the Post Office has collected 11,238 tons of waste paper, 7,000 tons of scrap lead, 6,766 tons of scrap copper and bronze, and more than 600 tons of old mail bags. Scrap stores recovered by engineers and postmasters and at factories and depots have been sold for the sum of 700,000*l.*

ELECTRICITY FUNCTIONS OF MINISTER OF WAR TRANSPORT.—By an Order in Council dated September 11, the functions of the Minister of War Transport (as successor to the Minister of Transport) in relation to electricity were transferred to the Board of Trade. Communications relating to electricity, intended for the Board of Trade, should be addressed to New Oxford House, Bloomsbury Way, London, W.C.1. (Telephone HOLborn 4311.)

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY.—Undergraduate courses extending over three years and leading to the degree of B.Sc. Tech. and to University Certificates in mechanical, electrical and municipal engineering, general chemical technology, metallurgy and assaying, electro-chemistry, fuels, chemical engineering, textile chemistry, paper manufacture, building and mining, are held by the Faculty of Technology of the University of Manchester in the Municipal College of Technology in that city. An outline prospectus of the courses, giving conditions of admission and particulars regarding fees, post-graduate work, halls of residence, and other matters of interest to intending students, is obtainable from the Dean of the Faculty, The University, Manchester. The 1941-42 session opens on Thursday, September 25. A leaflet prospectus of the part-time day courses in engineering and other technical subjects and of week-end courses leading to the Associateship o the College and to ordinary and higher National Certificates in engineering, chemistry, building, etc., has also been issued. The week-end courses commence on Saturday, September 20, and the part-time day courses on Monday, September 22. Copies of this prospectus may be obtained on application to the Principal, Municipal College of Technology, Manchester.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There has been practically no change in the state of the steel trade in Scotland during the week. Direct Government contracts are absorbing the current output, and steel for general purposes is almost unobtainable. Specifications for ship and boiler plates are coming in steadily, but as production has been on such a large scale during recent months the makers are able to meet all demands without much delay. Inquiries are numerous for structural material, and light sections are moving freely. Makers of black-steel sheets are busy, but to ensure continuity in production some new contracts would be welcome. Supplies of raw materials are adequate at present, but scrap steel is not very plentiful. Prices show no change and are as follows:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—The recent improvement in the malleable-iron trade of the West of Scotland has been well maintained and makers in this area have numerous orders in hand. The rivet, bolt and nut makers are specifying freely and other consumers are also sending in satisfactory orders. The re-rollers of steel bars report an increase in the amount of new business, which has been rather dull of late. They are well placed to meet the demand, and have ample supplies of raw materials as good stocks of semies are held. The following are the current quotations:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—Conditions in the Scottish pig-iron trade are unchanged. Foundry grades of iron are in good demand. To-day's market prices are as follows:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron 6*l.* 0*s.* 6*d.* per ton, both delivered at the steelworks; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

OIL PRODUCTION IN THE UNITED STATES.—The production of crude oil in the United States during the week ended August 30 reached a new high record, namely, 4,004,700 barrels daily. The average daily total for the preceding week was 3,975,450 barrels.

CONTROL OF EXPORT MATERIALS FROM THE UNITED STATES.—The Board of Trade has received information that synthetic fibres, wood, natural asphalt or bitumen, non-ferrous metals and precious metals, became subject to licence, as from September 10, on exportation from the United States.

THE LATE MR. H. A. GREEN.—It is with regret that we record the death of Mr. Henry Augustus Green, which took place at his home at Shenfield, Essex, on September 6. Mr. Green, who was 56 years of age, was managing director of Messrs. Murex, Limited, metallurgists and manufacturers of pure metals and alloys, Rainham, Essex. He was also a director of Messrs. Murex Welding Processes, Limited, Waltham Cross, Herts. Mr. Green was elected a member of the Institution of Mining and Metallurgy in 1930.

ROYAL MARINE ENGINEERS.—The Ministry of Labour and National Service has announced that there are a limited number of vacancies for commissions in the Royal Marine Engineers, a corps engaged on Admiralty works ashore. Applicants must be between 25 and 45 years of age and have had considerable site experience in actual constructional work, preferably harbour works. Engineers who desire to be considered for commissions should get into touch immediately with the Central Register of the Ministry, 41, Tothill Street, London, S.W.1.

CONTROL OF MISCELLANEOUS CHEMICALS.—The Ministry of Supply has announced that the Miscellaneous Chemicals Control has been established at Iron Trades House, 1, Chester-street, Grosvenor-place, London, S.W.1, to deal with certain chemicals which, hitherto, have been administered directly by the Raw Materials Department, The Castle, Warwick. Mr. D. J. Bird, until recently deputy controller of fertilisers, has been appointed Controller. Responsibility for titanium dioxide; chromium pigments and compounds, including bichromates, chromates, chromium oxide and chromic acid; and chlorates, has already been transferred to the new Control, and correspondence concerning them should accordingly be sent to the Controller at the above address. Correspondence relating to other miscellaneous chemicals should continue to be addressed to Warwick Castle until further notice.

TWO-WHEELED LIFTING-PLATFORM TRUCK.

MR. E. R. BRIGGS, M.I.MECH.E., RUGBY.

FIG. 1. TRUCK TRANSPORTING STILLAGE.

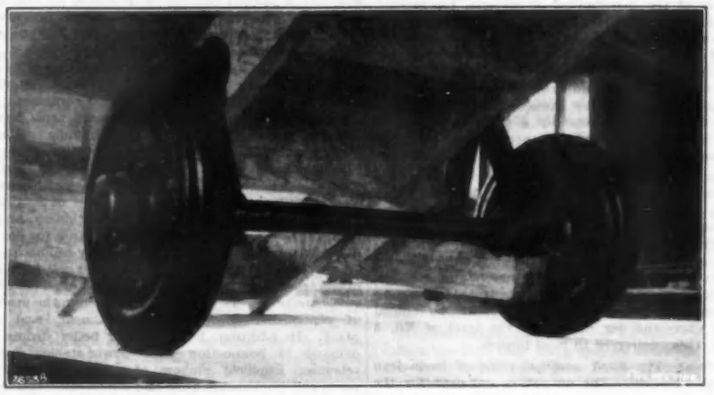


FIG. 2. UNDER SIDE OF TRUCK PLATFORM.

TWO-WHEELED LIFTING-PLATFORM TRUCK.

A COMMON practice in shops engaged in production work is to adopt the stillage system for the transport from machine to machine of small parts which undergo a series of operations; for example, turbine blades, small valves, camshafts, etc. The system consists of stacking the parts on a low table or stool known as a stillage, from early use in brewery practice, and removing this with its load by means of a lifting-platform truck, which is inserted under it. Hitherto, such trucks have been largely of the four-wheeled type which, though serviceable enough where readily accessible heavy loads are concerned, are often not sufficiently compact and mobile for handy manipulation in a crowded shop. The two-wheeled lifting platform truck, illustrated in Figs. 1 to 4, on this page, has been designed for such conditions by Mr. E. R. Briggs, M.I.Mech.E., 17, Lawford-road, Rugby. The normal load capacity of the truck is from 2 cwt. to 3 cwt., though, if desired, a load of 5 cwt. can be carried. The truck is shown in use in Fig. 1, in which an advantage of the system is obvious, since if the numerous small parts forming the load had had to be picked up individually from the shop floor after coming off a machine not only would more time have been occupied but there would be risk of damage from repeated handling.

The construction of the truck will be clear from Figs. 2 to 4. It is, at present, manufactured in one size only, with a platform measuring 18 in. in length by 22½ in. in width, and capable of carrying the loads stated above. The height of the platform in the transporting position is 12¾ in., which is suitable for a stillage 11 in. high from the floor to the underside of its platform, as shown in Fig. 3. If this height is maintained so as to give the necessary clearance for transport over an uneven floor, it is not necessary for the stillage to be of the type shown; thus, in cases where very small parts which will not stack easily are to be transported, a deep box form is used or a series of shallower boxes which stack one above the other. In using the truck the platform is run under the stillage in the position shown in Fig. 3, with the handles tilted forwards so as to depress the platform into a sloping position, the platform being pivoted in brackets attached to the lower end of the handles. It will be clear from Fig. 4 that when the handles are depressed into the wheeling position, Fig. 1, a crossbar between them makes contact with prolongations of the longitudinal members of the platform so that the platform is tilted into the horizontal position, in which position it remains during transport. The force required to depress the handles and lift the loaded stillage is not great, even with the maximum load of 5 cwt. mentioned above. With an evenly distributed load, its centre of gravity is about 4 in. in front of the axle and the length of the handles is sufficient to give a leverage of 10 to 1, a ratio which would require a force of about 56 lb. to balance it. The more common lighter loading is naturally more easily and rapidly handled.

The truck, as will be recognised from Fig. 2, is made largely of wood, an all-metal construction being unsuitable for present conditions though designs provide for its subsequent production. The platform is of oak, and the remainder of the woodwork of selected ash. The brackets which carry the axle and the platform pivot shaft are of whiteheart malleable cast iron. The pivot shaft passes through cast-iron bushes bolted to the longitudinal members of the platform. The wheels are 9 in. in diameter over the tread and have cast-iron centres fitted with roller bearings. Rubber cushion tyres are provided. In service, the truck has proved very mobile since it can be turned round on its own gauge as the wheels rotate independently, and is able to take sharp corners, while breaks in the floor level can be easily negotiated. It is stated to be free from vibration and silent in operation, rendering it suitable for the transport of fragile articles and for use in such institutions as hospitals.

Fig. 3.

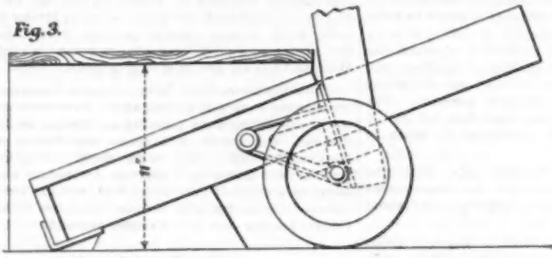
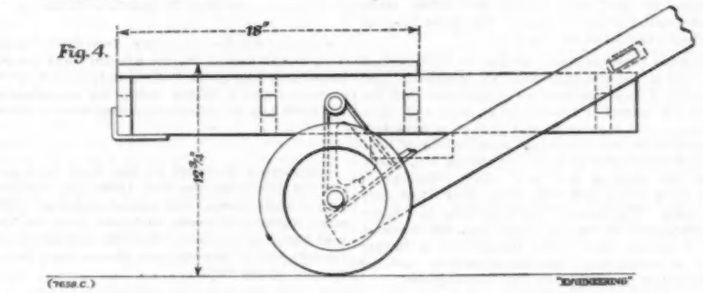


Fig. 4.



NORTHAMPTON POLYTECHNIC.—During the session, 1941-42, full-time day courses in engineering and applied optics, part-time day courses in engineering, and week-end courses in engineering, instrument making, telephony and optics are to be held in the Northampton Polytechnic, St. John-street, London, E.C.1. The week-end courses are intended as a substitute for evening classes, which are suspended for the time being. They will be held, provided sufficient enrolments are forthcoming, from 2 p.m. to 4.30 p.m. on Saturdays and from 10 a.m. to 4.30 p.m. on Sundays. Leaflets containing brief particulars of the courses are obtainable from the Principal. The session for the full-time day courses begins on Monday, September 29; for the part-time day courses on Monday, September 22; and for the week-end courses on Saturday September 20.

CONTROL OF IRON AND STEEL.—The Ministry of Supply has issued the Control of Iron and Steel (No. 15) Order, 1941, Direction No. 2, which came into force on August 31, 1941. This extends until September 30, 1941, the period during which orders for all iron products, except pig iron but including iron castings, may be fulfilled without being authorised by the responsible Government Department. The extension applies only to orders placed before September 1, 1941, which, if the No. 8 Order had remained in force, would not have required to be licensed. The exemption from licence or other authority of small purchases of iron castings has been extended from quantities not exceeding 2 cwt. to quantities not exceeding 5 cwt. Copies of the new Direction may be obtained on application to H.M. Stationery Office, York House, Kingsway, London, W.C.2.

EARLY GEAR-CUTTING.—Although it is fairly common knowledge that the machine cutting of straight bevel gears was practised early in the 19th century, a recent discovery has shown that what has hitherto been regarded as a modern development, viz., the machine-cutting of spiral bevel gears, was carried out between the years 1820 and 1840. This item of engineering history is recorded, with some interesting photographs of actual examples, in the August issue of *Contact*, the journal of the David Brown group of companies. Another anticipation of present-day practice lies in the fact that the early gears referred to above had tooth spaces semi-circular at the bottom, a form which was re-invented with the application of geared turbines to marine propulsion. The bringing to light of early methods by examining an old-established firm's records is not the least of the functions of a house journal and Messrs. David Brown's example is one worth following.

ENGINEERING.

Offices for Publication and Advertisements, 35 & 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and other publications bearing somewhat similar titles.

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TELEPHONE NUMBER—TEMPLE BAR 3663 (2 lines).

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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING." Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

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THE BRITISH MERCANTILE MARINE.

As its sponsors probably expected, quite a breeze of conflicting opinion has been raised by Lord Marchwood's motion in the House of Lords, on September 10, urging the appointment of a Royal Commission "to inquire into the conditions of service" in the Mercantile Marine, "with a view to raising the status of the personnel and constituting the Mercantile Marine as one of the National Services of the country." The motion was supported by the Earl of Cork and Orrery and by Lord Chatfield, both naval officers of distinction, and was well received by other peers who could claim some knowledge of the merchant seaman, although it was criticised by Lord Wright, expressing the views of the Officers' Mercantile Marine Federation, and by Lord Strabolgi, presenting those of the National Union of Seamen. The Minister of War Transport (Lord Leathers), speaking in the House for the first time since his elevation to the peerage, gave it as the Government's opinion that there was no justification for the appointment of a Royal Commission, and declined to appoint it, "because there already exists, in the form of the National Maritime Board, an organisation representative of officers, seamen and employers which is fully competent to deal with the problems relating to the well-being and conditions of sea-going personnel. . . . The appointment of a Royal Commission would certainly interrupt its smooth working, as it would become difficult for the Board to take decisions on any matters which might be before the Royal Commission. The result of the appointment of a Commission would thus be not to expedite, but to retard, the progressive improvement of conditions in the industry." Lord Marchwood, while withdrawing the motion, protested against the "unsatisfactory and almost unsympathetic" reply of the Minister, and expressed his intention to raise the question again.

The foregoing paragraph very briefly summarises the course of the proceedings; but, in common with most Press comments under present conditions of paper shortage, suffers from the disability that a mere report of the results of a debate may easily fail to make clear the basic arguments on which the original proposal was founded. In the present instance, Lord Marchwood (a qualified master mariner) and his naval supporters have been vigorously assailed from many quarters for their supposed desire to nationalise the British mercantile marine, and much of the argument to which the reported proceedings have given rise has been based on this supposedly fundamental feature. Actually, however, as the *Official Report* makes perfectly clear, Lord Marchwood was at pains to disclaim at the outset that he had any such intention. "I should very much like to emphasise," he said of the motion, "that it is in no sense a move in favour of nationalisation, nor is it a reflection on shipowners generally." The Earl of Cork, if he did not express any repugnance towards nationalisation, certainly said nothing to indicate that he was in favour of it; and Lord Chatfield was flatly and most emphatically against it. "I am not one who believes," he declared, "that the Merchant Navy should be run by the State. No one who, like myself, has experienced the agonies of a fighting Service being looked after by the State, blowing hot and cold, according to the political atmosphere of the moment and the convenience of the moment, can view with equanimity the prospect of the conduct of the Merchant Navy being turned over to Whitehall. It would be a terrible thought to me. Its independent responsibility . . . has been typical of the adventurous spirit of the people of these islands, which would never have resulted from State control."

It is only reasonable that such clear expressions of opinion should be given the fullest prominence, for there is a real danger that the supporters of this motion may find themselves regarded, and quoted, in the future as being supporters of a complete policy of nationalisation. That such a view should be held of the motion itself is not altogether surprising, for its wording, taken as it stands and without the explanatory speech with which Lord Marchwood submitted it, is certainly open to such an interpretation. How the mercantile marine of any country could be constituted "as one of the National Services of the country" without being nationalised in the process is a puzzle to which none of the speakers offered any satisfactory solution. The Earl of Cork certainly observed that "the line of demarcation between industrial interests and national interests would have to be clearly drawn," and implied that it would be one of the functions of the proposed Royal Commission to indicate where and how it should be drawn; but such a suggestion does little to clarify the issue.

The plain fact is that, where the mercantile marine is concerned, legitimate industrial interests and national interests are one and the same: there can be no question of drawing lines between them. A flourishing merchant fleet is the finest asset that this nation can have, but it can only flourish if it is in a position to compete on reasonably level terms in the world's carrying trades. There are many who maintain as a matter of principle that all public services should be nationalised, on the ground that the public benefit is the sole justification for their existence; but if the criterion of what constitutes a public service is that it is for the public benefit, the mercantile marine has always been a public service in the most comprehensive sense of the term. The danger—and the virtual certainty, if experience elsewhere is any guide—is that a nationalised service would become much less a source of benefit to the public as a whole than is the case at present; although a small section of that public, deriving direct employment from it, would probably succeed in improving their own immediate circumstances at the expense of the rest. To suppose that nationalisation would abolish present managements is absurd: there is no body of officials that could be successfully substituted for the skilled staffs now operating the mercantile marine. They could not be practicably abolished: but they could be overridden, interfered with, hampered at every turn by red tape, and generally prevented from working efficiently by a superposed organisation of permanent officials.

It is difficult to see how any scheme of Government supervision of the kind apparently contemplated by Lord Marchwood could fail to develop, or deteriorate, into just that nationalisation which he so emphatically disclaims any desire to bring about,

unless the successive Governments, of whatever political complexion, are prepared to confer upon the industry all the advantages of State backing without requiring any *quid pro quo* in the way of effective control; and that is rather too much to expect. Even though something approaching such a condition of affairs might appear to exist in other directions—for example, in the case of sugar manufacture—it does not extend to the provision of an official status comparable with that of the fighting Services, and nothing less would seem to be adequate to the recognition desired by some of the speakers.

No parallel that is even approximately exact can be drawn between the ruling economic conditions in the merchant service and those in any branch of public service within these islands, because sea trading is essentially an extra-national occupation. Ships engaged in trade with other countries, as the majority of British ships are engaged, are subject to economic pressure and influences which no single national government can control or materially relax; governments themselves seldom make economic conditions, except to a limited and almost a local extent, though they may easily worsen those conditions by ill-considered action.

A great deal still needs to be done to improve conditions in the British mercantile marine as a whole, if the ideal visualised by the Minister of Labour and quoted by Lord Marchwood is to be achieved; namely, that a boy entering the merchant service (we are not enamoured of the term "Merchant Navy") can look forward to "a complete career, with good pay and a pension at the end, with his accommodation worth while, and a feeling of pride in his craft." All these things are possible, and some of them are already well in train. That they do not reach fruition more rapidly is not altogether the fault of the shipowner, who has had difficulties to contend with, especially during the past ten or fifteen years, that the public comprehend very imperfectly or not at all, and which the Government have done singularly little to ameliorate. It is urged as a complaint against the shipping industry that its personnel are only casually employed. Apart from the undoubted fact that many of them, especially among the men, prefer to be engaged only for the voyage, it must be borne in mind that a majority of the ships themselves are only casually employed.

An exact economic balance between markets is never likely to be achieved if only because it is still impossible to guarantee uniformity of the harvests which provide a great part of seaborne merchandise and pay for so much of the manufactured products which form the cargoes in the reverse direction; therefore there must continue to be inequalities in the employment of ships. In such circumstances, regular employment of State-operated ships—always more expensive to run than privately-owned vessels—can only be ensured by some process of discrimination, the very antithesis of that freedom upon the seas that is one of the dreams of the future. The "Atlantic Charter," presumably, regarded the "freedom of the seas" primarily as freedom from armed interference, but freedom can be rendered ineffective by other means than arms, as British shipowners have had cause to know within recent years. The solution of the problem is not clear, nor is it likely to be expedited by legislation which merely imposes fresh burdens upon the shipowner without alleviating those which are inseparable from his business so long as he must conduct it in competition with the ships of other nations, and especially of those nations which have developed flag discrimination into a fine art.

So far as the working conditions of seafarers themselves are concerned, it is significant that there are some British owners who have very little trouble in obtaining officers or men, or in retaining them; whose directors take a personal interest in making life at sea worth living for their ships' companies, and whose men, though still nominally "casually employed," actually spend their whole lives under the same house-flag. By suitable inducement, it should be quite possible to make such conditions much more general than at present, and that without nationalisation or a national uniform, without any fresh spate of involved legislation and without even the appointment of a Royal Commission.

ELECTRIC-POWER SUPPLY IN ONTARIO.

THE co-operative municipal organisation which administers electric-power supply in the Province of Ontario has been in existence for 34 years, and has been supplying power for more than 30. Although Ontario is the chief industrial province of Canada, a very large part of the area covered by the Hydro-Electric Power Commission is farming or undeveloped country, and from the first it has been the policy to assist agricultural development by extending distribution lines into rural areas. Grants to cover capital and other charges to assist in this work have been made from time to time and have been met from the general tax revenue of the province. With this exception, however, the Hydro-Electric Power Commission is, and always has been, entirely self-supporting. The Commission was formed in 1907, as a result of an agitation to conserve the water power of Ontario as a valuable public asset and for the provision of general low-cost power supply in the southern part of the province. In general terms, the duty of the Commission is the supply of electricity in bulk to the municipalities, which, in turn, distribute it to the consumers. Both operations are carried out on a non-profit-making basis, the charges made being adjusted to cover operation, maintenance and capital costs and the building-up of a sinking fund. In rural districts, in which the individual towns are too small and too scattered to undertake the operation of public electric-supply, distribution, as well as bulk supply, is carried out by the Commission.

Although the operation of the business of electricity-supply by a public, or semi-public, body is familiar in this country, we have nothing actually corresponding to the Hydro-Electric Power Commission of Ontario. This body, which consists of a chairman and two Commissioners, appointed by the Lieutenant-Governor in Council, acts as trustee for the municipalities which, for this particular purpose, operate in groups, each covering an independent power system. Each group forms a separate financial unit. Various modifications have taken place in the constitution of the groups during the 30 years operation of the Commission, but in the southern, and more thickly populated, part of the province, a stable constitution has now been reached. The municipalities are divided into three groups, constituting the Niagara System, the Georgian Bay System, and the Eastern Ontario System. Of these, the Niagara System, which covers the south-western part of the province, and abuts on Lake Huron, Lake Superior and Lake Ontario, is the largest and most important. It includes Toronto and embodies the important generating plants situated on the Niagara River. The Georgian Bay System lies to the north of this, abutting Lake Huron and Georgian Bay; the Eastern Ontario System lies to the north of Lake Ontario and extends eastward to the Ottawa River, which divides Ontario from Quebec. There is a fourth municipal group covering the Thunder Bay System, lying to the north of Lake Superior, around Lake Nipigon. The most important towns in it are Port Arthur and Fort William.

Although these municipal groups are operated as independent financial units, they are not isolated in a technical sense and the whole of the generating stations in the three southern systems are interconnected by transmission lines. This enables assistance to be given by one district to another in case of difficulty in one area, which might, for instance, be caused by an ice block on a river. Large amounts of power are also purchased from private plants, so that the operation of the generating capacity of the province is co-ordinated. The extent of the Province of Ontario, however, is so great that the whole of its supply systems are not interconnected; we have not yet reached complete interconnection even in this small country. The Thunder Bay System is an isolated unit, supplied from Cameron Falls and Alexander power stations, both situated on the Nipigon River. Power supplies in the Northern Ontario properties are furnished by four independent supply systems. The extent to which advantage is taken of the existence of private generating plants in the province, as a whole, is illustrated by the fact that while, in the financial year which ended on October 31, 1940, the Commission generated 6,564,248,186 kWh, it purchased 3,122,154,225 kWh.

The status which the successful conduct of the Commission has allowed it to take in the sphere of public administration is well illustrated by the fact that, in 1929, its operations were extended to include the Northern Ontario Properties. These large areas are now administered by the Commission in trust for the province. The territory contains 51 mining properties, six towns, and ten villages, and power is supplied by the Commission to the Canada Northern Power Corporation, which operates in the northern part of the area and in portions of the Province of Quebec. To a large extent the power in these relatively undeveloped areas is utilised for mining work, although rural agricultural supply is also covered, but it is chiefly in the southern part of the province that farm supplies have been developed. Ontario has an area of 363,282 sq. miles, of which 35,700 sq. miles are agriculturally developed. The rural population served is 1,100,000 and power is being supplied to 123,000 consumers. In 1939-1940, the rural supply aggregated 70,018 h.p., showing an increase of 13·6 per cent. over the previous year. The network of primary rural lines has a total length of 19,492 miles. It is estimated that there are some 200,000 farms in the province, varying in size from one to 600 acres. It is not anticipated that the whole of these will ultimately be supplied; some are in very remote districts and some have no residential buildings. There is, however, still room for much further extension. It is estimated that the farm-motor load represents at present only 15·4 per cent. of saturation, the corresponding figure for cream separators being 6·6 per cent. For the farm-house, some higher figures are shown, and the electric-iron saturation is put at 75·3 per cent.

The latest annual report of the Hydro-Electric Commission, covering the year ended October 31, 1940, shows continued expansion in nearly every field of supply. The total output of generated and purchased power showed an increase of 13·9 per cent. over the previous year and the supply of bulk power increased by 19·2 per cent. The greater part of this latter figure was accounted for in the Niagara System and was explained by rising demands from electro-metallurgical and electro-chemical plants situated in the neighbourhood of the Niagara River. The increases were mainly due to the growing production of war material. The effect of this latter type of accelerated demand was not, however, confined to the Niagara System, and the activity of war industries in the Georgian Bay and Eastern Ontatio Systems was reflected in increasing loads. The total energy output in the former of these showed an increase of 14·6 per cent., although the peak load did not increase until October when a munitions plant, which went into production in September, began to build up its load. The lack of peak growth during the summer months, when demands on the system are usually at a maximum, is attributed to the effect of the adoption of daylight saving. Twelve municipalities in the area adopted daylight saving in the summer of 1940. This advanced the time of the peaks in those communities by one hour, with the result that although there was a substantial growth in the individual municipal loads during the summer, the diversity caused by changing the times of the peak loads in the twelve municipalities was sufficient to enable the whole system to be served with practically no increase in the peak of the system as a whole. In Eastern Ontario, the bulk-load peak increased by 9·3 per cent. over the previous year, the total bulk energy supplied increasing by 13·5 per cent. In this area, daylight saving was extended to the winter months, but this was not found to produce any appreciable reduction in the winter peak.

STANDARDISATION OF HOLLOW-WARE.—With the object of effecting economy in the use of labour and materials, the Board of Trade has issued the Hollow-Ware (Control of Manufacture) Order, 1941 (S.R. & O., No. 1345). This provides for standardisation in the manufacture of hollow-ware in general demand, principally for domestic purposes. The Order comes into effect on September 24.

NOTES.

USE OF LEND-LEASE MATERIALS.

As a result of discussions which have taken place between British Ministers and the United States Ambassador, correspondence has been exchanged and laid before Parliament as a White Paper, setting out the policy of H.M. Government in the United Kingdom in connection with the use of materials received under the Lend-Lease Act. So long as it was necessary to pay cash for whatever supplies were required from the United States, the first consideration was that we should earn the greatest possible amount of dollars. Every effort was accordingly made to increase our exports even at the cost of very great self-denial upon the part of United Kingdom consumers. Since that situation was widely appreciated among manufacturers for export, and because industry must lay its plans many months ahead, it will doubtless happen that some goods continue to arrive in the United States and South American markets in the days of the Lend-Lease Act, the delivery of which was planned in the days of "cash and carry." While the export policy of H.M. Government must still be to maintain such export trade as is possible, it must be a trade properly directed to sustain the war effort, and controlled so as not to allow of the use of Lend-Lease materials to facilitate competition with the United States. The White Paper, which contains a memorandum addressed by Mr. Eden to Mr. Winant is very definite on questions of policy. It states that all materials which we obtain under the Lend-Lease Act are required for the prosecution of the war effort. This principle governs all questions of the distribution and use of these goods and H.M. Government have taken, and will continue to take, action that these goods are not in any case diverted to the furtherance of private interests. It is further emphasised that Lend-Lease materials sent to this country have not been used for export, and every effort will be made, in the future, to ensure that they are not used in this way. The general principle followed in regard to the distribution within the United Kingdom of Lend-Lease goods is that the remuneration received by the distributors, whatever the method of distribution, is controlled, and will be no more than a fair return for the services rendered in the work of distribution. In most cases Lend-Lease supplies will be distributed through organisations acting as agents of H.M. Government in the strict sense of the term, and not as principals. Where for strong practical reasons this cannot be done a full explanation will be supplied to the United States Administration and their concurrence sought beforehand on any alternative arrangements proposed. The justification for retaining existing channels of distribution, operating under strict Government control, is that the creation of elaborate new organisations in their place would inevitably result in loss of efficiency and the wasteful use of man-power, thus retarding the war effort. In connection with H.M. Government's resolve that Lend-Lease supplies of every kind shall be used for the good of the community as a whole and for the prosecution of the war effort, the Board of Trade wish it to be known that close contact will be maintained with Export Groups regarding any question which may arise. Exporters are therefore advised to address any correspondence on the subject to their Group.

THE GRAMPIAN POWER SCHEME.

On September 10, on the motion of Mr. E. H. Keeling, the House of Commons rejected the Grampian Electricity Supply Order Confirmation Bill, thus reversing the recommendation of the Parliamentary Commissioners who conducted the inquiry into the Order at Edinburgh. The object of the Bill, it will be recalled, was to empower the Grampian Electricity Supply Company—a statutory body charged with the task of generating and supplying electricity in certain parts of Scotland—to construct a hydro-electric power station in Glen Affric, in the county of Inverness. Under the Private Legislation Procedure (Scotland) Act of 1936, four Commissioners were appointed to consider the Provisional Order covering the undertaking, two (Lord O'Hagan and Lord Doverdale) being nominated by the Chairman of Committees of the House of Lords, and the other two (Major B. H. Neven-Spence, M.P., and Mr. George Buchanan, M.P.), by the Chairman of Ways and Means, in the House of Commons. The inquiry was held in Edinburgh in April, 1941, the hearing occupying ten days, and the Commissioners recommended that the Order authorising the construction of the plant should be issued, subject to certain modifications. After some discussion of the motion on September 10, the Rt. Hon. Tom Johnston (Secretary of State for Scotland) said that there had been two main objections urged against the scheme: first, that it would destroy the natural amenities of the district, and, secondly, that it involved the development of certain assets of the Highlands for the benefit of other parts of the country. There was a third objection, namely, that the Bill proposed to hand over to a private corporation great natural water-power resources. It was true that the State was to be given an option to purchase the undertaking at the end of 75 years; but, even so, for three-quarters of a century these natural resources would be handed over to a private corporation. These considerations had been fully examined by the Commissioners, but there was also a wider principle to be considered. The scheme could not be started during the war, for neither labour nor materials was available. The House must decide, therefore, whether to proceed with a measure which could not be operated now or in the near future, but which, if passed, would tie the hands of the Government of the day when the whole question of regionalisation of area and ownership of hydro-electricity came to be considered. If the powers were conferred, the effect would be that of mortgaging the future, and of doing it in advance of any operational necessity. There was no need to assume that Parliament would delay its decision on the future of hydro-electric development until after the war; arrangements were being made for the preparation of schemes for the future planning of other natural resources, and on this point an announcement would be made shortly. There would be a free vote on the motion. What the House had to decide was whether it desired to hand over specific powers over Highland water, to be operated by a private corporation until the year 2016; or whether Parliament would reserve its decision as to the future utilisation of these assets until the Government was in a position to make a better estimate of post-war conditions and to bring forward its own proposals for co-ordinating the hydro-electric resources of the country. He advised the House to accept the motion for rejection. This was agreed to.

"THIRD CLASS ONLY" TRAINS.

Some weeks ago it was announced in the House of Commons that the Minister of War Transport was contemplating the abolition of first-class compartments on suburban trains in the London area, in order to ease congestion during the rush-hour periods. In a notice issued by the Ministry on September 11, it is stated that the change is to take effect on and from Monday, October 6, when "all trains which both begin and end their journeys within the London Passenger Transport Area, extended to certain points somewhat beyond that area, will be third-class only." First-class accommodation will continue to be provided in trains which begin or end their journeys outside the area, even though they make stops within it. "This decision applies to 5,000 trains," the statement continues, "and, as a rough guide, includes Bletchley, Bedford, Hitchin and Bishop's Stortford in the north; Witham, Upminster and Gravesend in the east; Sevenoaks, Horsham and Guildford in the south; and extends on the G.W.R. to Reading in the west." A special sign has been devised for use in time-tables, at the entrances to platforms and on station departure boards, to identify the third-class only trains. According to the Ministry, the change has been made to meet "war-time difficulties," which implies, without actually promising anything, that the two-class system will eventually be restored; though it is hardly to be expected that this can take place for some time after the conclusion of hostilities—it will be recalled that the congestion on the London suburban lines was much worse in 1919 and 1920 than it was at any time during the last war. Present circumstances are somewhat different, however; heavier raiding from the air has placed an exceptional strain upon the reserves of rolling stock from time to time, for one thing, and the number of persons travelling into and out of London daily has increased considerably in the past twenty years, for another. On the whole, the rolling-stock position is easier than it might have been, but a set train with half of its windows broken is temporarily immobilised almost as effectively as it would be by more serious structural damage. A factor which may have influenced the decision to abolish first-class travel is the virtual impossibility, under war conditions, of ensuring that only holders of first-class tickets use first-class compartments, even during the slack periods. Evasions have been common for a long time, and the staff has not been available to provide an efficient check on the practice, which is obviously unfair to those who have paid the considerable surcharge for the sake of what is, on the more populous suburban lines, a very slight improvement in amenities at the best. Nevertheless, it would be quite incorrect to argue from the case of the Tubes and the District Railway that the time is now ripe to abolish the first class permanently on the suburban lines; there is still a definite field for it, and one which might show really profitable returns if intelligently cultivated. That much has been demonstrated by experience on the electrified system of the Southern Railway. The eventual solution of the problem of overcrowded thirds in conjunction with empty firsts is not obvious, however. Some relief might be afforded by providing a proportion of convertible compartments, such as are found on the electrified line between Newcastle-on-Tyne and Tynemouth, and which can be made first or third class at different periods of the day, as traffic may require. Much more might be done, too, to allay the irritation of standing third-class passengers by altering the make-up of trains that are reduced in length when the rush is officially (but not actually) over, so that a larger proportion of firsts is sent to the sidings and more thirds retained in use. It is conceivable, however, that one outcome of the present change may be the institution of "first-class only" trains, or of "club" trains, on the lines of those on the old Lancashire and Yorkshire Railway. Trains for first-class passengers only have been run for years in connection with race meetings and other special events, and, though their introduction into regular suburban time-tables may involve some problems in operating economics, these might well appear in a new and less discouraging light under post-war conditions.

RAILWAY COLLISION AT HOLMES CHAPEL.

The accident record of British railway working is singularly free from those arising from defects in the roadbed, and the signalling system is of a very high standard. It is perplexing, therefore, to account for such an accident as that which occurred in the early hours of Sunday, September 14, at Holmes Chapel station on the direct line between Crewe and Manchester, and approximately half-way between the former town and Alderley Edge. The accident was the result of an overtaking collision, an express train from Crewe to Leeds being nearly stationary when a train from Crewe to Manchester ran into it. As is the general rule in such cases it was the stationary train that suffered most, its two rear coaches being shattered with a resultant death roll of nine persons and injuries to some 40 others. The engine of the overtaking train was considerably damaged and turned over on its side, the driver and fireman escaping by jumping on to the near embankment when the collision was imminent. Two of the coaches behind this engine were derailed and the track was torn up over a length of about 50 yards. As the accident took place before sunrise rescue work was handicapped by darkness, but a searchlight in a nearby field proved of great service in the task of extricating the dead and injured, who were removed to hospital in private cars and tradesmen's vans. The line was, of course, blocked and the organising of alternative routes was necessitated.

OBITUARY.

MR. H. D. MADDEN.

We have learned with much regret of the death, on September 8, of Mr. H. D. Madden, for many years chief engineer and manager of the Cardiff Gas Light and Coke Company. Mr. Madden, who was in his 66th year, retired in April of this year, when he was succeeded by Mr. Frank Boardman, M.I.Mech.E., who had been manager and engineer of the Grangetown gasworks of the company. For some time, Mr. Madden had been in poor health and, soon after his retirement, he left Cardiff for Cheltenham, where he died, as stated, on Monday of last week.

Henry Dacre Madden was born on March 29, 1876, and received his early education at North London Collegiate School. His engineering education was obtained at the Regent-street Polytechnic, where he twice won the silver medal in gas engineering. Leaving the Polytechnic in 1899, he began a three-years' pupilage under Sir Corbett Woodall, M.Inst.C.E., in the course of which he also served as a temporary member of the staff of Sir John Aird and Company, on public works contracting. In 1902, he was appointed assistant resident engineer at the Beckton works of the Gas Light and Coke Company, having charge, in turn, of each section of the works, and having further experience in the drawing office, on tidal surveys, and on general engineering work. This appointment lasted until 1906, when he went to Cardiff as resident engineer of the Grangetown gasworks under the late Mr. H. Morley, then chief engineer of the Cardiff Gas Light and Coke Company.

His appointment as chief engineer in succession to Mr. Morley, three years later, marked the beginning of an extensive programme of reconstruction in the company's works and distribution system, involving eventually the expenditure of more than half a million pounds. Because of the situation of the works, it necessitated an unusual variety of engineering construction, including the reclamation of tidal lands and heavy foundation work on the reclaimed site, and the laying of more than 75 miles of mains, ranging in diameter from 6 in. to 24 in., designed for both low-pressure and high-pressure distribution. In addition, Mr. Madden acted from time to time as consulting engineer to other gas undertakings, among which may be mentioned the Brynmawr and Blaina Gas Company, whose works and distribution system he redesigned; the Rhymney and Aber Valley Gas and Water Company; and the Llanelly Gas Company. He was also called upon to give evidence before various Parliamentary committees in connection with questions of gas supply, and was the author of a number of papers read before the Society of Chemical Industry, the Wales and Monmouthshire Institution of Gas Engineers, the Institution of Mechanical Engineers, and other technical bodies.

During the last war, Mr. Madden served as advisory engineer, in an honorary capacity, on Lord Moulton's Committee on High Explosives, and carried out special research work on T.N.T. and ammonia-base explosives. He was also engineering adviser for South Wales to the Coal Controller. For four years he held a commission in the 2nd (Volunteer) Battalion of the Welch Regiment. He was a member of the executive committee of the National Gas Council and chairman of their District Board for South Wales, and a member of the Fuel Research Board from 1929 to 1933; and, in November, 1940, he was appointed gas-engineering adviser to the Regional Commissioner for Wales. Mr. Madden took an active part in the work of institutions and associations connected with both the technical and administrative sides of gas production and utilisation. He became an associate-member of the Institution of Mechanical Engineers in 1907, and a member in 1922, and, as chairman of the South Wales Branch of that institution, served on the Council in 1929-30. He was elected a member of the Institution of Civil Engineers in 1923. He was, of course, a well-known member of the Institution of Gas Engineers, of which he was president in 1927-8; an office which he held on three occasions in the Wales and Monmouthshire Institution of Gas Engineers, previously mentioned. He was also chairman, in 1939, of the executive committee of the British Commercial Gas Association.

MR. A. T. WALL, O.B.E.

Less than a year has elapsed since Mr. A. T. Wall retired, for reasons of health, from the position of managing director of Messrs. J. Samuel White and Company, Limited, Cowes. We have now to record, with regret, that he died on September 14, at his home in Cowes, at the early age of 55.

Mr. Wall was born in Plymouth on February 11, 1886, and attended Stoke Public School, Devonport, for six years before commencing, in 1900, a five years' apprenticeship at the Royal Dockyard. On its completion, he proceeded to London to study engineering subjects for two years at the Royal College of Science, where he was awarded a first-class associateship in physics; and naval architecture, for a further two years, at the Royal Naval College, Greenwich, where also he succeeded in obtaining a first-class certificate. He left the Royal Naval College in 1909 to take up an appointment as assistant naval architect at the Thames Ironworks, Blackwall, where he subsequently became assistant chief draughtsman; and, when this old-established shipyard was closed, he went to Liverpool as chief draughtsman to the Booth Steam Ship Company. In 1913, when only 27 years of age, he was appointed chief naval architect to Messrs. Cammell Laird and Company, Limited, Birkenhead, where he remained until 1920.

Photo: Burrell and Hardman.

THE LATE MR. A. T. WALL.

He had not held this position long when the decision was taken to establish a chair of naval architecture at the University of Liverpool, and for this new professorship Mr. Wall was a candidate. Fortunately, perhaps, in view of the war that broke out so soon afterwards, he was unsuccessful; for the flood of Admiralty and mercantile work which soon engaged his attention was on a scale that called for all the robust strength that he then possessed. During his regime at Birkenhead, he was responsible for the design of some notable vessels, including the light cruisers Birkenhead and Chester (originally laid down for the Greek Navy) and the first self-propelled all-welded ship, the Fullagar; and he also prepared the first design for a reinforced-concrete ship to receive the approval of Lloyd's Register. During the war, too, he served as a member of the Lancashire Anti-Submarine Committee, and carried out a number of experiments on their behalf. For his work as chief naval architect at Birkenhead in the war period, he was awarded the O.B.E.

In 1920, Mr. Wall relinquished his position with Messrs. Cammell Laird and Company and started practice on his own account in Liverpool as consulting naval architect, and in this capacity also he was responsible for some noteworthy ships. He was retained by the Cosulich Line, in an advisory capacity, in connection with the building of the large transatlantic motor ships Saturnia and Vulcania; designed, and supervised the construction of, the five passenger and cargo liners of the Lady Nelson class, built by Messrs. Cammell Laird and Company for Canadian National (West Indies) Steamships, Limited; and, in conjunction with Mr. John Johnson and Mr. H. Macdonald, respectively the superintendent engineer and naval architect of Canadian Pacific Steamships, Limited, he acted in a similar capacity in connection with the five fast cargo liners of the Beaver class. Eventually, however, after some 12 years of independent practice, he returned to the constructional side of shipbuilding in November, 1932, as managing director of Messrs. J. Samuel White and Company, a position which he occupied with notable success until ill-health compelled him to retire last year.

Mr. Wall was a member of the Institution of Naval Architects and was elected to a seat on the Council in 1928. Since 1937, he had been a vice-president. He contributed a number of papers to the *Transactions*, and was awarded the Institution Premium in 1916. He was also a past-president and Derby Gold Medallist of the Liverpool Engineering Society, a Fellow of the Society of Consulting Marine Engineers and Ship Surveyors, and a liveryman of the Worshipful Company of Shipwrights. During his professional career, he was responsible for the design of over 70 merchant ships that were actually built, and his death in what should have been the height of his considerable abilities, is a definite loss to the shipbuilding industry.

PROFESSOR A. G. GREEN, F.R.S.

We note with regret the sudden death of Professor Arthur George Green, which occurred at his house at Walton-on-Thames on September 12. Professor Green, who was formerly director of research, British Dyestuffs Corporation, and late Professor of Applied Chemistry (Dyestuffs), at the University of Leeds, was the son of the late Mr. W. J. Green, F.R.I.B.A., and was born in London in 1864. He was educated at Lancing College, Sussex, and at University College, London. In 1886, he joined the staff of Messrs. Brooke, Simpson and Spiller, aniline colour manufacturers, London, as chemist. He continued in this capacity until 1893 when he was appointed chief chemist of the Clayton Aniline Company, Manchester. Relinquishing the position in 1901, he was afterwards appointed Professor of Tinctorial Chemistry and Dyeing in the University of Leeds, the name of this department being afterwards changed to that of Applied Chemistry (Dyestuffs). Professor Green subsequently became director of research to the British Dyestuffs Corporation. He will always be remembered for his contributions to organic chemistry, particularly in connection with the chemistry of colouring matters and the general question of the relationship between colour and chemical constitution. He was the discoverer of Primuline, the first representative of a valuable series of sulphur-containing colouring matters which have been of great service as cotton dyestuffs. Professor Green was the author of many papers on organic compounds and colour chemistry, and he also wrote two books, *A Systematic Survey of the Organic Colouring Matters*, published in 1903, and *The Analysis of Dyestuffs and their Identification in Dyed and Coloured Materials*, published in 1915. He was a Perkin Gold Medallist and a Research Medallist of the Dyers Company of London and had held advisory appointments to manufacturers of dyestuffs in this country, the United States, and on the Continent. Professor Green was elected a Fellow of the Royal Society in 1915. He was a Fellow of the Institute of Chemistry and of the Chemical Society, and a member of the Society of Chemical Industry.

SAFETY IN MINES.

THE coal industry ranks at all times as one of the most important of the national industries, and in war it is doubly essential that it should operate at the highest possible efficiency. Efficiency, however, is synonymous with safety. Accidents, apart from the human suffering and loss that they cause, imply contributory loss and waste in various forms, all of which, directly or indirectly, result in reduced output. During the past twenty years, a great deal of valuable research work has been carried out by the Safety in Mines Research Board and much more space than is here available would be required to attempt even an outline of the results accomplished by this organisation since its inception. Unfortunately, as with so many other national institutions, loss of staff to war work or service with the Forces, and other conditions due to the war, have interrupted and curtailed activities at the Research Stations; added to which, new problems arising from the war call for investigation by the Board, whose difficulties were further intensified by the loss of two outstanding members, Sir Edward Troup and Professor R. V. Wheeler.

In view of these handicaps it is gratifying to learn from the Annual Report for 1939, which was recently published,* that the Board's policy has been, and is, to make every effort to maintain its research organisation in being, and to continue those researches already in hand which have the most direct bearing on the safety and health of the miner, and promise early results. Naturally, the Report is much shorter than usual; a general account is given of the progress of researches during the year, but detailed descriptions of experimental methods and results have had to be omitted.

Some interesting results were obtained in experiments in the underground roadway to ascertain the effect on the development of a coal-dust explosion of stone dust deposited otherwise than in a homogeneous mixture with coal dust. These experiments were begun in the preceding year, but were continued under somewhat different conditions. The coal dust, prepared from the Red Vein Seam (Glamorgan), had a volatile-matter content of 23 per cent. on the free-ash dry basis, and 85 per cent. of it could pass through the 240-mesh B.S. test sieve. The incombustible dust was waterproofed limestone, and 66 per cent. could pass through the same sieve. The explosions were started near the closed end of the roadway in a turbulent cloud of coal dust. Without further addition of coal dust, the flame spread 125 ft. along the roadway. When a 50 : 50 mixture of the coal dust and limestone was spread for 250 ft. in front of the source of ignition at a rate of 4½ lb. per linear foot, the flame was extended by only 85 ft. When, however, the same quantities of the two dusts were spread separately, one dust on the shelves and floor on one side of the road and the other dust similarly on the other side, the explosions travelled to the open end of the roadway, another 410 ft. The whole length of the roadway was then dusted, first with limestone at the same rate as before, then with coal dust on top of the limestone at half the rate, thus forming a layer of coal dust $\frac{1}{8}$ in. thick and an average of limestone dust to coal dust of 2 : 1. Under these conditions the explosion travelled throughout the roadway.

The experiments thus demonstrate the need for mixing the stone dust, that is spread on mine roadways, with the road dust, and show that an explosion cannot be depended upon to mix the dusts sufficiently for the stone dust to exert its full effect. As it is not practicable to effect perfect admixture in a mine roadway, every effort should be made to give the stone dust an opportunity to rise first in the path of an explosion; for example, by spreading it widely so that, as far as possible, the coal dust shall always be smothered by the stone dust. Another and an important part of the remedy lies in improving the dispersibility of the stone dust, a characteristic which the foregoing experiments gave opportunities to study. It was again observed that the raising of the stone and coal dusts during an explosion may be either by steady erosion of particles from the surface or by violent and irregular disturbance. When the blast does no more than erode, stone dusts generally are less disturbed than coal dust. Deposits of stone dusts, however, are apt to set up the irregular disturbance, and their movement then becomes greater than that of adjacent deposits of coal dust. Limestone dust which had been exposed in the roadway for four days before test was readily dispersed by the explosion, but, of six deposits of a gypsum similarly exposed, only two remained dispersible; it should be noted, however, that the humidity of the atmosphere was over 90 per cent. The physical process by which a dust deposit is dispersed as a cloud is being studied with a view to finding a proper basis on which to measure and improve the dispersibility of stone dusts.

In the report for 1938, the statement was made that the incorporation of ½ per cent. of palmitic or stearic acid during the grinding of limestone dusts made them highly resistant to moisture. This method of "waterproofing" has been applied to gypsum and shale dusts in the laboratory, but the result was not obtained so readily with limestone and was less satisfactory. The best results were obtained by previously mixing the dust with finely powdered stearic acid and milling at a temperature above the melting point (70 deg.) of the acid. Specimens of waterproofed limestone and precipitated carbonate dusts, prepared in the laboratory or received from outside sources, have remained dispersible during four months' exposure. Generally, but not invariably, it was found that the treatment improved dispersibility. Experiments have also been made to determine the effect of waterproofing a limestone dust on its efficacy for suppressing the inflammation of coal dust. When mixed with Red Vein (Glamorgan) coal dust, it was found that 55 per cent. was required to suppress propagation of flame, as compared with 47·5 per cent. of non-treated limestone. The reason for the reduced efficacy is not yet known; possibly it is an avoidable consequence of the treatment. As the finest particles of a dust are the most harmful physiologically, the question arises whether the removal of such particles from an incombustible dust would render it less efficacious for suppressing an explosion of coal dust. Comparative tests were accordingly made; the results indicated that an appreciable loss might be expected by the removal of any considerable proportion of the fine particles.

It is well known that, in certain districts, firedamp is sometimes ignited in the cut during coal cutting, probably by the picks encountering pyritic inclusions or hard siliceous rock. The suggestion has been made that carbon dioxide should be fed into the cut from nozzles at the tip of the jib. Solidified CO_2 was put into a compartment on the coal cutter and the gas which it developed was discharged through a reducing valve into a pipe attached to the nozzles. Experiments were devised to determine the proportion of CO_2 necessary to make ignition impossible. From the plotted results it would appear that a linear relationship holds between the chance of ignition and the concentration of CO_2. On this assumption it is found that with 21·1 per cent. of CO_2, the probability of ignition is apparently nil, and consequently complete safety should be obtained. Although this conclusion is not strictly legitimate, statistical treatment shows it to be approximately correct, for the chance that the limiting percentage of CO_2 will be greater than 24·9 per cent. is only one in a million. Thus, however, it is shown that a much larger rate of addition of CO_2 is necessary in the cut than the 1·5 cub. ft. per minute used in experiments made in 1938 by Manchester Collieries, Limited, in collaboration with Imperial Chemical Industries, Limited, and Messrs. Anderson, Boyes and Company, Limited, to test the findings of S.M.R.B. Paper No. 81. The quantity of 25 per cent. of CO_2 may prove prohibitive from the practical engineering point of view; hence it would appear that the most promising method of preventing ignition in the cut would be to use some material to suppress the igniting source. Water, of course, is the most obvious, but as the problem is somewhat similar to that of keeping a tool cool in turning, probably it would be better to use a cooling liquid consisting of soap, oil and water. This would wet better and would be less liable to corrode the cutter chains and picks. Water alone has been used extensively in the United States to reduce the production of dust. If, however, such large quantities were used in this country, floor troubles would be caused in many pits. Further investigations are being made regarding the amount of coolant needed to prevent ignition.

Numerous tests have been made to ascertain what danger of inflammation of firedamp may arise from the friction sparking that may occur during the operation of certain chock releases. It was found that sparking was readily produced and that it was not possible to suppress it with the releases in question. Although no ignition was obtained during the tests, this is not sufficient proof that it cannot occur, and the question of designing a new chock-release, to be non-sparking, is being taken up. The ignition of firedamp by mining explosives is an ever-present danger, and while the use of sheaths decreases the danger, tests indicate that it is not equally effective with all explosives on the permitted list. Experimental work has been in progress for some time to devise a test which will distinguish between those explosives which can be improved by sheathing and those which cannot, and which will serve, in addition, as a means of measurement in attempts to improve the effectiveness of sheathing. Such a test could also be the basis of an official test for sheathed explosives.

The problem of falls of ground, one of the most prolific causes of accidents in mines, involves a study of the control of strata during all phases of mining operations. The subject also has an important bearing on other matters, such as ventilation and the formation of coal dust. Investigations in longwall workings can be carried out in advance of the coal face, within the working area; at the coal face, and behind the face, and in or near roadways. Whenever possible, observations have been made in all three of these regions during the same period, to establish relationships between the results and, more particularly, to explain the occurrence of periodical movements at the face. The work done during the year under review in advance of longwall faces has included observation of movements by convergence recorders in a heading driven 140 yards ahead of a double-unit face at a depth of 900 yards. The seam, 4½ ft. thick, was overlain by 1½ ft. to 2 ft. of weak mudstone, then 6 in. to 12 in. of cannel, followed by thick sandstone with occasional conglomerate beds. Initial movement of the beds in the vicinity of the heading had occurred when it was driven, but the recorded movements were caused by the advancing coal face. In nicks 1 ft. deep, cut into the side of the heading, convergence beneath the mudstone was recorded 115 ft. ahead of the face; in a nick 6 ft. deep, movement was first recorded 90 ft. from the face. Movement beneath the cannel at the middle of the heading was observed at 105 ft., and at the side, 152 ft. from the face. Convergence between the sandstone and the floor had already commenced when the recorder was set, 118 ft. ahead of the face. The effect of coal cutting was recorded 25 ft. to 30 ft. ahead of the face beneath the mudstone, 10 ft. to 15 ft. ahead beneath the cannel, and 27 ft. ahead beneath the sandstone. In all cases, convergence within the area affected was slower at week-ends, and, on resumption of work, movement was less than normal during the first day.

The information obtained ahead of and behind the coal face indicates that a large area of roof lowers substantially in one mass. This reveals the important function of the temporary roof supports and packs in the vicinity of the face. The normal lowering in a complete cycle of work includes a short period of acceleration caused by cutting or coal-getting, followed by a period of retardation and a longer period of steady lowering at an almost uniform rate, interrupted by a short accelerated movement set up by the withdrawal of supports. The period of retardation is important because it reveals the efficiency of the supports in arresting the accelerated movement set up by cutting. Roof movement is practically continuous, and the rate and amount caused by the different coal-face operations vary with the effectiveness of

* *Eighteenth Annual Report of the Safety in Mines Research Board*, 1939. London: H.M. Stationery Office. [Price 1s. net.]

the roof control. Abnormal roof conditions at the coal face are mostly related to the failure of beds above the immediate roof.

The relation between surface subsidence, height reduction behind the coal face, and pack loads, has been investigated on a double-unit face in a seam 3 ft. 6 in. thick at a depth of 90 yards. There was no obvious evidence of floor lift in the roadway and, therefore, bed separation was indicated by the greater roof movement at a place in the worked-out area than at a point vertically above the surface. The maximum difference was about 4 in. at 60 ft. behind the face. At 150 ft. behind the face, the surface subsidence became equal to the underground height reduction, indicating a closure of the beds. The pack loads measured near the gate-side wall, and in the middle of the road-side pack in the centre gate road, were greatest at 150 ft. and 180 ft. from the face, respectively. It is at about these distances that complete contact of the beds seems to have been made again.

The possibility of using reinforced-concrete pit props has received considerable attention of late, and certain investigations are referred to in the report. It was found that props made of a good mixture of cement, gravel and sand, with the ends of the props bound by steel wire and with adequate reinforcement, were able to withstand repeated setting and withdrawal. A plain steel tube, 8 in. in diameter and 8 in. high, weighing 10 lb., placed on the floor and filled with machine cuttings, on which the prop is set, ensures that with normal convergence the prop cannot be overloaded, permits a pre-determined amount of yield to accommodate roof subsidence, and allows the prop to be withdrawn without damage. Adequate resistance is afforded, which can be controlled by varying the size and depth of the cuttings in the tube and the cross-sectional area of the base of the prop in contact with them. The tube device is also useful for the repeated use of wood props, but it is an advantage to use a steel disc between the foot of the prop and the machine cuttings to prevent burring. Regularity in the setting and withdrawal of concrete props is necessary, and the success of their application is enhanced by the use of efficient complementary supports in the form of packs and chocks.

In the foregoing summary it has been possible to touch on only a portion of the material dealt with in the report, but the selection presented should serve to indicate the diversity and complexity of the problems encountered by the Safety in Mines Research Board, and the methods adopted in their solution.

NOTES FROM NORTH AMERICA.

THE United States Navy Department announced early in August that 34 new vessels for the rapidly growing two-ocean navy were launched during July. The new vessels included one light cruiser, three destroyers, one submarine, five coastal minesweepers, three submarine chasers, six motor torpedo-boats, six net tenders, two gate vessels, and four harbour tugs. Keels laid during July total 63 and included those of one aircraft carrier, two light cruisers, ten destroyers, three submarines, eight minesweepers, two coastal minesweepers, two minelayers, one repair ship, three seaplane tenders, two minelayers, five submarine chasers, and 24 motor-driven minesweepers.

Mr. R. C. Vaughan has succeeded Mr. S. J. Hungerford as president of the Canadian National Railways and the affiliated companies and subsidiaries, which include the Canadian National (West Indies) Steamships, Limited, Canadian Government Merchant Marine, Limited, and the Trans-Canada Air Lines. Mr. Vaughan, who is 57 years of age, was formerly vice-president in charge of purchases, stores, and steamships for the railways, and his railway career extends over a period of 42 years. When the Canadian Dominion Government set up the Defence Purchasing Board in July, 1939, Mr. Vaughan was appointed chairman of that board. Mr. Hungerford, who was made acting president of the railways in 1932 and president in 1936, will continue as chairman of the board of directors. The new arrangement will give him more time to devote to the railway's war work. He will also continue as president of the National Railways Munitions Board. Another change within the railways is the appointment of Mr. H. J. Symington, K.C., as president of the Trans-Canada Air Lines, another post relinquished by Mr. Hungerford. The new head of the air lines was solicitor of the Grand Trunk Pacific Railway from 1906 to 1909 and has been a director of the Canadian National Railways since 1936.

Work was begun by the United States Bureau of Reclamation, during August, on the Anderson Ranch Dam on the south fork of the Boise River, 25 miles south-east of Boise, Idaho. The earth fill structure, which will require 10,000,000 cub. yd. of earth, will rise 444 ft. above the lowest point in the needed cut-off trench, and will be highest earth-fill dam in the world, according to Bureau of Reclamation engineers. The project will be for power, flood control, and irrigation purposes. The construction of a hydro-electric plant of 30,000 kW capacity is included. It is expected to generate 104,000,000 kWh of electricity annually and to eliminate flood damages averaging 275,000 dols. yearly. The dam will be about 2,900 ft. thick at the widest part of the base and the structure will have a crest length of 1,350 ft. The reservoir to be created will have a capacity of 500,000 acre-ft. For the construction of the dam and power house, 1,670 calendar days are allowed, and the power plant is expected to be in operation late in 1945 or early in 1946. The Bureau of Reclamation engineers state that this will not only be the highest earth-fill dam, but the fifth highest of any type in the world, and will be exceeded only by the Boulder, Shasta, and Grand Coulee dams in America and the Cambon Dam in France. The Boulder Dam, on the Colorado River, is 726 ft. high; Shasta Dam, on the Sacramento River, will have a height of 560 ft. when complete, and Grand Coulee, on the Columbia River, is now just about to its final height of 550 ft. Figures are not available for the exact height of the Chambon Dam, but it is over 444 ft.

During August, the Office of Production Management, which is the Federal body set up to co-ordinate America's war effort, placed the distribution of steel, pig iron, silk, and vanadium under industry-wide mandatory control, because of the scarcity of these commodities. The other materials so controlled include aluminium, magnesium, nickel, nickel-steel, ferro-tungsten, tungsten high-speed steel, machine tools, copper, cork, borax, polyvinyl chloride, zinc, chromium, cutting tools, calcium, silicon, and rubber, including synthetic rubber. The controls are so strict that much industrial and commercial work of a non-defence nature has been curtailed where large supplies of one or more of the above materials were needed. Federal control of the use of still more materials is expected in the near future and chemicals are expected to be one of the first groups added to the priorities list.

Eleven American oil companies have applied for Federal permission to build jointly a 1,820-mile pipe-line to transport crude oil from the fields of Texas and the Midwestern States to the Philadelphia-New York area on the Atlantic seaboard. This pipe-line, which it is believed would be longer than any yet built, is designed to transport 250,000 barrels daily. The pipe-line would vary in size from 16 in. to 24 in. in diameter, most of it of the latter size.

Due to the transfer of several ocean tankers to uses for the British Empire and at least four to aid in supplying Russia with important materials, shortages of oil in the north-eastern part of the United States has already developed and various measures have been taken to reduce the demand. As one means of overcoming the shortage, numerous pipe-lines are under construction. This work includes a 236-mile pipe-line from Portland, Maine, to Montreal, Canada, for transporting crude oil; the long refined-products line from St. Joe, Florida, to Chattanooga, Tennessee; and the 1,000-mile line to transport gasoline from Baton Rouge, La., to Greensboro, North Carolina.

Because the Federal Bill was passed during August, to permit the United States War Department to continue the training for more than one year of many of the 1½ million American men now in service, the War Department soon afterwards entered upon a programme which is expected to result in the construction of many large Army cantonments. During the month, contracts were awarded for four such camps, each expected to cost about 20,000,000 dols., and each to house about 18,000 men. In addition, sites have been chosen for 19 more camps, which are expected to cost still more, and to make the average cost for the 23 camps about 23,000,000 dols. The construction of many additional camps will be started at once if European conditions become more serious.

Mr. R. E. Jamieson, professor of civil engineering and chairman of the department of civil engineering and applied mechanics at McGill University, Montreal, has been made Director-General of a new Army engineering design branch of the Canadian Government's Department of Munitions and Supplies. Professor Jamieson will assist a special inter-departmental advisory committee on Army engineering design problems. A native of Ottawa, Professor Jamieson received a B.Sc. degree from McGill University in 1913. Following service overseas as a lieutenant in the Canadian Siege Artillery from 1916 to 1918, he continued his engineering studies at McGill and in 1920 received his M.Sc. degree. Soon afterwards, he joined the teaching staff of the University, and, in 1931, was appointed William Scott Professor of Civil Engineering, and chairman of that department.

The United States production of aeroplanes during 1941 is estimated by the Office of Production Management, which is America's Federal body organised to speed up the production of war goods, at 18,000 machines to 20,000 machines. The production of 1940 is expected to be tripled, and 1939 production to be improved upon by 700 per cent. During July of this year, American factories produced 1,460 aircraft, which is about equal to the output for June, when 1,476 units, or more than in any previous month, were delivered. Since April, when deliveries increased by more than 200, passing the 1,400 mark for the first time, production has been fairly steady. The schedule for September is 2,000 machines and that for December, 2,700. During July, 55 per cent. of the total production was estimated to consist of training machines; by December, however, fighting aircraft are scheduled to account for nearly 60 per cent. of all production. To date, the American aviation industry has been devoting the major part of its activities to tooling-up for mass production, but a few facilities, constructed during the past year, are now coming into production and should increase the monthly output greatly. Available figures reveal that the aircraft industry in August had on hand orders totalling 65,000 aeroplanes, when all those for the United States Army and Navy, and for the British Government and other agencies, were included. The heavy-bomber production programme calls for an output of 500 four-engined bombers monthly. This goal, on the basis of present plans, cannot be reached until early in 1943. The output of large bombers will probably rise relatively slowly during the remainder of 1941, to reach about 100 a month, but will increase very rapidly early in 1942. By the second half of 1942, American plane production will be at the rate of 3,000 per month, according to the Office of Production Management.

Production of passenger automobiles by Canadian factories during 1942 will be reduced to less than 50 per cent. of that for 1940, when 110,126 cars were manufactured. The Dominion Government has ordered an arbitrary reduction to about 44 per cent. of that for 1940, and a further reduction may be ordered later. Manufacturers have undertaken voluntarily to reduce the number of models of passenger cars for sale from 147, offered last year, to 79. A reduction in the output of heavy and light delivery trucks is also planned, in order to conserve steel and machine tools.

OIL AND MOISTURE IN COMPRESSED AIR.

PRESENT-DAY conditions in the use of compressed air not infrequently involve a somewhat hurried lay-out of the pipes and connections to the tools or machines served by the compressor, with the result that trouble may arise from the carry-over of oil and water with the air. It is impossible to avoid some of the lubricating oil escaping in the form of vapour from the compressor cylinder and, under normal conditions, all atmospheric air contains a percentage of water vapour, the moisture retaining capacity increasing with rise of air temperature. Thus for each rise in temperature of 27 deg. F. double the amount of vapour can be retained. Conversely, if the absolute pressure be doubled the amount of water vapour that can be held is halved. If the compressed air is cooled to the same temperature as it has when free, a large proportion of the contained moisture will condense in the form of water which can be drained away. The discharge from an air compressor is usually high enough in temperature to evaporate all the moisture, which then remains in the air until the supply reaches the piping system in which it is cooled by radiation with subsequent condensation.

In installations for which Messrs. Broom and Wade, Limited, High Wycombe, supply compressors they recommend that an aftercooler be fitted on the delivery pipe between the compressor and the air receiver. If this apparatus is properly designed it will reduce the temperature of the air leaving the cooler to a figure not exceeding 20 deg. F. above that of the water entering the cooler. Under these conditions, and with reasonably cool water, practically the whole of the oil and moisture is condensed and collected in the sumps of the cooler and receiver whence it can be drained, and so prevented from reaching the service mains. The arrangement of these mains should, however, receive attention. The air main between the receiver and the service main should have a fall of 1 in 40 towards the receiver, to assist in draining, and a drain cock should be fitted at the lowest point of any fall in the service main. The pipes to the tools or machines from this main should be led from its upper surface and a separate drain from each supply pipe, fitted below the point at which the actual connections to the tools are led away, will be of service.

LABOUR NOTES.

MR. GRENFELL, the Secretary for Mines, stated in the House of Commons last week that miners who had left the pits for other work and who registered in July totalled 105,376. Of these, 25,468 were willing to return to the mines. A very substantial proportion of those registering had left the pits owing to physical incapacities or were engaged in occupations withdrawal from which would cause proportionate detriment to the war effort. Sixteen thousand men had already been placed in work, of whom about two-thirds were face workers. In addition, a substantial number had been directed to return to the mines. The Government trusted, Mr. Grenfell added, that with the arrangements now being made it would be unnecessary to recall men from the fighting forces. Since the House last met the output of coal had been much affected by holidays, and progress in adding to stocks had been slow. With the added men now available, however, he looked forward to a rapid improvement.

During June, 939,000*l.* was paid out in unemployment benefit and unemployment allowances. In the House of Commons Sir Herbert Williams asked why that should be so, in view of the shortage of man power for the war effort. The Minister of Labour and National Service explained that industry was not yet so completely organised that it could give employment in all cases. A comparatively small number of workers were, for various reasons, unable to move to districts output of coal had been much affected by holidays, and in which employment was available for them and of which they were capable.

Three resolutions on the subject of wages were adopted at the Llandudno conference of the Transport and General Workers' Union. One expressed alarm at the failure of wages to rise correspondingly with the increased cost of living, and noted the increased profits of the big monopolies. The opinion was emphasised that the full industrial and political strength of the organisation should be used to secure wage increases for members. The second resolution instructed the executive council and officers to take the initiative on all wage-negotiation machinery in order to bring wartime wage advances into line with the increased expenditure that workers have to meet owing to war conditions. It further demanded that the Government should take all possible steps to prevent a further rise in the cost of living.

The third resolution dealt with the wages of women workers and called upon the Government and local authorities to put into operation immediately the principle of the rate for the job. Wages and compensation rates of women civil defence workers, it was declared, should be on the same level as those of men. The executive council was also urged to approach the Trades Union Congress in order to secure action by the whole of the trade union movement to establish the principle of the rate for the job in all industries and immediate increases in the basic rates for women's work in the engineering and all other trades.

It will be observed that the executive council was "urged to approach the Trades Union Congress in order to secure action by the whole of the trade union movement." Judging from the editorial notes in a recent issue of the Amalgamated Engineering Union's *Journal* the Trades Union Congress does not expect the affiliated unions to adhere to any decision arrived at by it on questions of wages or working conditions. The writer in discussing the Government's White Paper and the General Council's reply to it. He says:—"No decision taken by the T.U.C. General Council on such a question of policy as this can bind the affiliated unions. The autonomy of unions on all matters affecting the interests of their members and conditions of employment in their trades is absolute. No union can delegate this authority to any other organisation with which it may be connected by way of affiliation. As far as the Amalgamated Engineering Union is concerned we must say quite clearly that its wage policy will be determined by the union and by nobody else. We could not take directions from the T.U.C. General Council, nor from the Congress nor even from a special conference of trade union executives if one should be called to consider these two documents. It is due to our members to make this clear."

At a conference in Leicester last week, of the National Association of Trade Union Approved Societies, a recommendation was adopted that all employers should be obliged to contribute to a National Compensation Fund which would secure benefits for all workers injured while following their employment. The resolution also proposed that the Workmen's Compensation Act should be abolished. The opinion was expressed that the change would put an end to the existing scandal of insolvent employers and liquidated companies. The recommendation is to be sent to the Government Committee which is considering the question of social insurance.

In order to meet the pressing need for more men and women, trained in radio and engineering, the minimum age limit for applicants for State bursaries is being lowered. Boys and girls who attained a sufficient standard in mathematics in the Higher Certificate Examinations, held this summer and reached the age of seventeen before July 1, will be considered for these awards. State bursaries cover the payment of fees and of a maintenance allowance equivalent to the full cost of living at the university or technical college to which the bursar is allocated. It is urgently necessary in the national interest, the Board of Education says, that as many young people as possible who have done sufficiently well in mathematics and physics in their Higher Certificate Examination should make application for these awards.

In a long resolution, the executive council of the International Association of Machinists—which is in the United States and Canada the equivalent of our Amalgamated Engineering Union—defines the position of the organisation on the subject of apprenticeship. It is stated that with the development of the Defence Programme and the increased requirements for machinists and other classes of machine-shop employees eligible for membership of the Association, the shortage of machinists is becoming acute. "This has resulted," the declaration continues, "in many public agencies attempting to develop machinists or specialists in N.Y.A. projects, manual training rooms of the vocational schools, etc., which definitely proves that these agencies are not familiar with the requirements of the machinists' trade and are attempting to justify their existence in this manner. The result is a tremendous waste of public funds and misguidance of youth through a misunderstanding of this problem."

The International Association of Machinists, the resolution goes on to say, is "deeply concerned" about this situation. It appreciates the fact that it is its responsibility "to assist materially in this emergency, and at the same time to offer as much protection as possible" to the skilled workers in the trade. After much deliberation it has decided that the problem can be answered only "by a real and practical machinists' apprenticeship," and that the only Government agency which is constructively approaching the problem is the Federal Committee on Apprenticeship Training—a Division of the United States Department of Labour.

"The Federal Committee on Apprenticeship Training," it is pointed out, "has definite standard requirements for apprenticeship, one of which is that an apprenticeship system shall be developed and established by industry itself, through the joint participation of management and labour." With that policy, the executive says it "most heartily" agrees. It recommends local lodges to co-operate in the carrying on of apprenticeship activities with managements, with whom they have collective agreements, and advises them to call upon the staff members of the Federal Committee for assistance when necessary.

Reviewing the work of German women in the munitions industries since the outbreak of war, the writer of an article in *R.K.W. Nachrichten* says that the experiments made in the autumn of 1939 when women were temporarily required to work on night shifts proved unsatisfactory, because it was found that women could not stand the unusual strain for any considerable periods. Absences from work increased in many undertakings up to 50 per cent. in the case of married women, and on Saturday nights the figure was as high as 80 per cent. Women, therefore, can now be employed on night work only in exceptional circumstances and by permission of the authorities.

Women, it is stated, have accepted the double day-shift much more readily, in which the hours are from 6 a.m. till early afternoon one week and from noon till 11 p.m. the following week. Where the working day is one of eight hours a rest period of 45 minutes has proved to be sufficient, allowing a quarter of an hour for breakfast. For the second shift a rest period of 30 minutes is allowed. Married women, because of domestic duties, try to obtain work in the normal day shift, and undertakings prefer to employ unmarried women or women with few domestic obligations for the double shift. The increased employment of married women having domestic duties had led to the introduction of a part-time scheme.

THE ADMIRALTY EXPERIMENT WORKS, TORQUAY.*

By R. W. L. GAWN, R.C.N.C.

(*Continued from page* 220.)

WILLIAM FROUDE and the staff of the Torquay Tank devoted early attention to the accurate recording and analysis of speed-trial results of ships. Many measurements were initiated and Froude's proposals, many of which were tried out, included pressure-log measurements of speed, wave profiles, sinkage and trim, as well as accurate timing on the measured course and accurate records of revolutions per minute, steam pressure, and indicated horse-power. His well-known analysis of indicated thrust and initial friction called attention to the magnitude of ship resistance and demonstrated that it was comparable with the estimates from his model experiments. Comparison of wave profiles between model and ship indicated the correctness of the Law of Comparison. When it was found that the effective horse-power was only 40 to 50 per cent. of the indicated horse-power, Froude examined the various sources of lost power with good accuracy and showed that much was lost in the propeller, a large proportion of which was unavoidable, as it was dispersed in the kinetic energy of the race. We owe an enormous debt in this branch of the subject to the combined efforts of Willliam Froude and his friend William Denny. Although the Admiralty made a few progressive trials on ships from 1836 onwards, and Thornycroft carried out some, the real credit for initiating progressive measured-mile speed trials is largely due to Denny. His system received Froude's wholehearted support, and is first described in Froude's paper in 1876† and by Denny in 1884.‡ The two Froudes numbered Denny among their greatest admirers, and the three shared common ground in their zeal for combining careful model experiments with careful ship-trial results. Denny also has the credit of establishing the first private experiment tank, and the second in the world, in 1884.

Very detailed reports were forwarded to the Admiralty by Froude on the minutiæ of speed-trial analysis, the careful system of comparison with the model persisted and was improved from time to time until it finally took the form given by Mr. M. P. Payne in the *Transactions* of 1934.§ One of the earliest detailed trial reports was on H.M.S. Shah in 1876. Froude was not satisfied with these trials on account of errors in speed, power, revolutions, tide, wind, and serious discrepancies in the propellers. One of the two blades of the propeller was erroneously adjusted to an excessive pitch of 29 ft. instead of the intended pitch of 24 ft. to which the other blade was adjusted, and the former became distorted in consequence. This report on the Shah was destined, unfortunately, to be Froude's last contribution on this branch of the subject.

The trials included measurements of wave profiles. Mr. (later Sir) Philip Watts recorded from hanging platforms the wave surface against vertical gradations at intervals along the sides of the ship, and Froude found that, while the results agreed with the model "very satisfactorily," the wave in the model had not, at that date, been noted with sufficient accuracy. He instituted more minute gradations in the model and other improvements since elaborated to give greater accuracy of recording. One serious difficulty in the Torquay Tank was that the observer noted the wave on the model from a stationary platform as the carriage moved past him. This method was altered in the Haslar Tank, when room was found to arrange for the observer to move on the carriage with the model. Actually the bow wave was found to be 3 in. higher in the ship, a circumstance which might have been due to the difficulty in distinguishing film from wave; and the stern wave was slightly higher, presumed due to propeller action in the ship. In 1884 another comparison was made of wave profiles, this time by R. E. Froude for the battleship Colossus, including transverse sections of the wave. It was found that the "agreement appears to me as good as can be expected, except perhaps at one point on the back slope of the bow wave," where the unusual profile in the ship suggested a local wave caused by a shoot or minor feature not represented in the model.

In a report on an analysis of the results of six ships, namely, Opal, and five ships of Encounter class, dated March 11, 1876, Froude found that the trials "do not supply a very satisfactory test of the relative goodness of the form of different ships," but that they had a scientific value in throwing "light upon other conditions

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* Paper presented to the Institution of Naval Architects. Abridged.

† "The Ratio of Indicated to Effective Horse-power," *Trans. I.N.A.*, vol. 17, page 167 (1876).

‡ "Mr. Mansell's and the late Mr. Froude's Methods of Analysing the Results of Progressive Speed Trials," *Trans. I.E.S.S.*, vol. 28, page 10 (1884).

§ "Ship Performance in Relation to Tank Results," *Trans. I.N.A.*, vol. 76, page 397 (1934).

THE ADMIRALTY EXPERIMENT WORKS, TORQUAY.

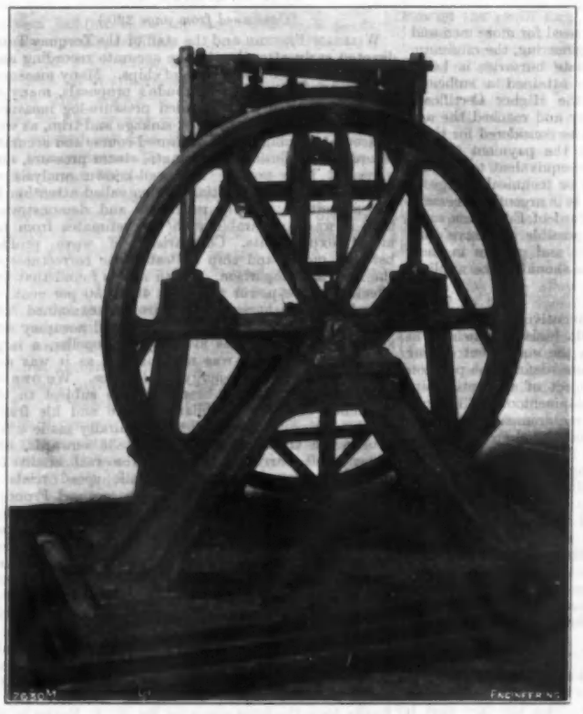


FIG. 25. AUTOMATIC ROLL RECORDER, 1872. LONG PERIOD.

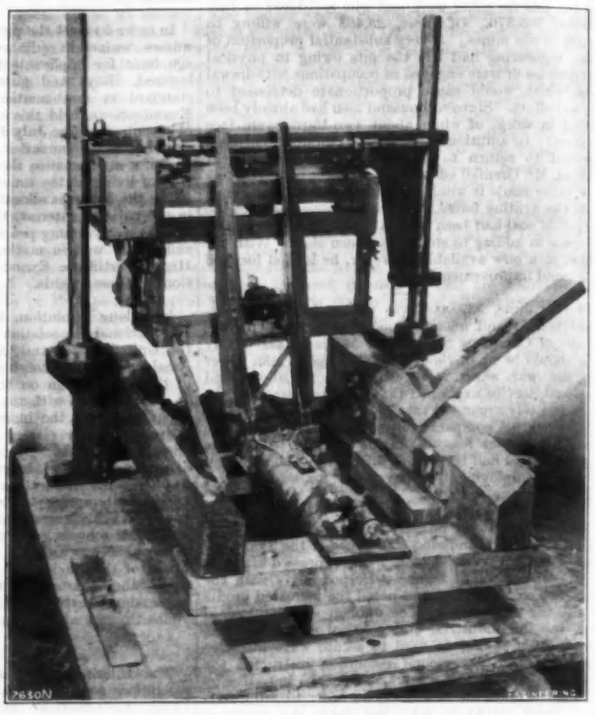


FIG. 26. SHORT-PERIOD PENDULUM, 1872.

of steam ships which model experiments taken alone cannot deal with." In these trials Froude showed that error was introduced if the steadying run before the beginning of the measured mile was not of sufficient length. By graphic integration he demonstrated that a run of 5,550 ft. was necessary from rest to work up to 13·5 knots with sufficient accuracy, and that, if the ship entered the mile while still accelerating, the mean defect of speed on the mile would be $\frac{1}{10}$ths of 1 per cent. If the approach distance were reduced by 1,000 ft., initial speed would be 1·5 per cent. in defect and average speed 0·2 per cent. These distances were greater than Froude anticipated and reacted more on the easterly run than on the westerly on the Stokes Bay mile. He also showed that error introduced by variation in tidal speed may easily be about $\frac{1}{4}$th of a knot with a further $\frac{1}{10}$th due to tidal irregularities, and about $\frac{1}{2}$ of a knot altogether due to insufficient length of run provided all the errors were accumulated. There appeared to be a maximum tide on the measured mile course of 2 knots. Timing errors on this course continued to give difficulty and eventually, in accordance with proposals from R. E. Froude, the beacons were removed to alternative sites to eliminate the positional error which had been a source of inaccuracy for some years.

One of the duties assigned by the Admiralty to William Froude was to measure the power delivered at the ends of the propeller shafts of ships. In order to escape heating and other troubles associated with a friction brake, Froude eventually evolved a turbine brake for use in connection with these ship experiments. This marine-engine dynamometer, 5 ft. 4 in. in diameter, to absorb 2,000 h.p. at 90 r.p.m., was made by Messrs. Easton and Anderson in 1878 to Froude's design and specification. A model instrument was made in the Experiment Works and later editions of this are still used for calibration of the power delivered to the propeller in the various dynamometers at Haslar. The brake was tried on H.M.S. Conquest in March and April, 1880, and fulfilled anticipations in all respects; in fact, the power was absorbed at 70 r.p.m., and greater revolutions per minute were only obtained by partly closing the screens to the turbine. A photograph of the test was reproduced in Fig. 14, on page 159, *ante*. The Conquest was a convenient vessel for first trial, having a lifting screw, which facilitated the use of the instrument. The dynamometer has not been tried subsequently, but its use was considered in the 1890's and at later dates, and although, owing to the changes in engine power, it proved unsuitable, the scope of such

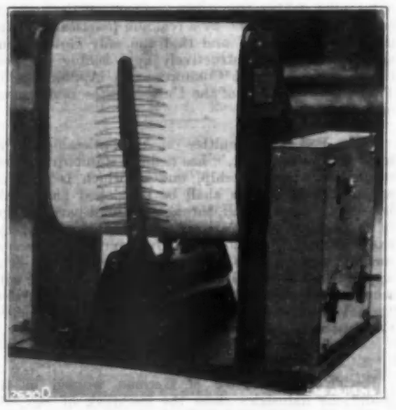


FIG. 27. HASLAR ROLL RECORDER.

a device for obtaining shaft-bearing and other losses requires no emphasis.

William Froude's fundamental work on rolling was well advanced before the establishment of the tank at Torquay. He confirmed his classical theories by ship trials and his work serves as the most brilliant beacon down to the present day; in fact, our conceptions of rolling are still much as Froude left them. Unfortunately, no trace can be found of the "few experiments on the rolling of floating bodies and especially on the rolling of bodies of ellipsoidal form," referred to in the Admiralty letter of February 1, 1870, approving the experiments at Torquay. It is presumed that they were never carried out. Two tests appear to have been made on rolling in the Torquay Tank. The first was for the Inflexible committee of 1877, of which William Froude was one of the four members. The report, dated December 4, 1877, includes the results of trials on a model of the Devastation and the ship, which were reproduced in last year's *Transactions*. The substantial agreement of the curve of extinction in model and ship encouraged the committee to test a large model of the Inflexible, weighing nearly a ton, in the Torquay Tank. It was constructed so that the extinction could be tested at different immersions and heights of centre of gravity, and with the unarmoured ends riddled and gutted in different degrees. Free water was found greatly to increase the extinction, so much so that the intact extinction at 10 deg. was equivalent to 1 deg., compared with 7·4 deg. when riddled and gutted. By graphic integration it was calculated that, in a synchronous wave 40 ft. high, the angle of deck to the horizontal when riddled and gutted would be 2 deg., and 7½ deg. to the wave surface. Another important test was the effect of damage on longitudinal stability. It was found that if the ship was damaged forward and open to the sea, all freeboard would be lost forward at 7 knots.

The ingenious automatic roll recorder or fly-wheel devised by William Froude was described in the *Transactions* for 1875. It was first used at sea on the Devastation in 1873, and as a result of experience was considerably modified under R. E. Froude's directions in 1882 for the Inflexible trials, the alterations including knife edges in lieu of rocker supports, separation of the short-period pendulum, and a damping trough to diminish the independent oscillations. Owing to the extreme nicety and delicacy of construction, this latter defect could never be completely eliminated and this reacted against the accuracy of the instrument, although it was used again on the trials of the Revenge in 1895, and was also used at sea by the present author in 1925 on the trials of the destroyer Vivien. Its primary purpose was the academic one of accurate measurement of wave-slope and of roll, as a contribution to the theory of rolling rather than as a test of rolling qualities of ships, for which latter purpose it is less suitable than the gyro and other recorders now available. William Froude's short-period pendulum, consisting of a weighted eccentric cylinder, has been used for many trials, modified from time to time, the latest edition being a general-purpose recorder simplified by the substitution of a clockwork for an electric timer. Photographs are reproduced in Figs. 25 and 26, on this page, of the "wheel" and of the original short-period pendulum, respectively. The 1940 edition, the Haslar roll recorder, is illustrated in Fig. 27.

Following the successful water-chamber trials on the Inflexible,* experiments were undertaken to determine the effect of water chambers in the Colossus class and

* "A Method of Reducing the Rolling of Ships at Sea," by [Sir] Philip Watts. *Trans. I.N.A.*, vol. 24, page 165 (1883).

THE ADMIRALTY EXPERIMENT WORKS, TORQUAY.

Fig. 28.

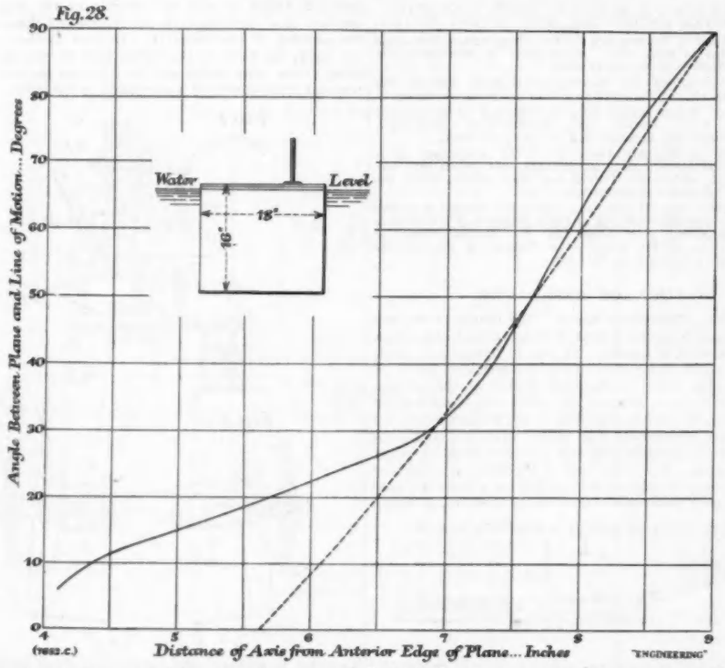


Fig. 29. ELEVATION

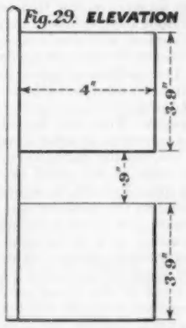
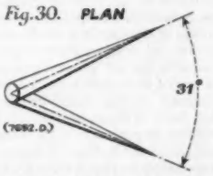


Fig. 30. PLAN



the advantage to be expected from an enlargement of the chamber. Trials were conducted by R. E. Froude on H.M.S. Edinburgh at Spithead in 1883. It was found that the ship could only be rolled up to 6 deg. by men moving across the deck, and it was estimated that the effort of the men was the equivalent of a synchronous wave of only ¼ deg. slope, say 500 ft. long and 3 ft. high. The trial thus only dealt with small angles, and deductions therefrom consequently gave an exaggerated idea of the rate of increase of damping at large angles. Froude made a model of the water chamber at a scale of 1 : 20·5 full size and suspended it above the waterway of the Torquay Tank on a pendulum corresponding in periodicity and stability to the ship. A paddle was hung below the pendulum, immersed in the water and adjusted to represent to scale the extinction due to hull and bilge keels. It was found necessary to represent on the model such excrescences as carlines, coal shoots, drain valves, etc., to obtain the proportional effect of the water chambers. Agreement with the ship was found to be very close in the "wipe out" condition (*i.e.*, for a depth of water in the chamber such that increase of depth does not increase damping), and in the other conditions was as close as could be expected under the circumstances. The results confirmed the marked effect of balance chambers on small amplitude of roll, contrasted with the inferior effect at large angles compared with bilge keels. For example, at 12 deg. roll each way, an extended chamber adds no more to the extinction than 2 ft. depth of bilge keels, and at 18 deg. only adds half as much. Both the long-period "wheel" and the short-period pendulum were used for the ship trials. An abortive effort was made to analyse the roll of the ship when being worked up by the men. The whole investigation was described in a voluminous report. The model fully justified itself, and enabled information on different arrangements of water chambers under a variety of conditions to be obtained both cheaply and quickly. R. E. Froude received from the Admiralty an official letter of appreciation for this important work.

On the Devastation trials William Froude used a novel method to measure the length of the waves. An india-rubber ball about 1 ft. in diameter was attached to a line on which lengths were marked with corks which served to float the line. The ball was veered away astern until it was judged that, at the instant a wave crest passed it, the next wave was against a marked portion of the ship's side, the intervening distance giving the wave-length. Froude considered that the arrangement answered its purpose very well.

Unfortunately, the manœuvring of ships does not appear to have been considered in great detail by William Froude, although some of the early reports on ship form show that it was not lost sight of, by the occasional references to the favourable effect of length on speed, coupled with the adverse effect on handiness. In 1875 there are records of letters between William Froude and Rev. J. Woolley, concerning the balanced rudder, which dealt, among other matters, with the disadvantage of a gap between rudder and hull; and with Lord Rayleigh, in 1877, concerning a few "hurried" experiments by Froude on the positions of the centres of pressures on planes moving obliquely. In the latter, Froude looked forward to the "imaginary glorious future" when he could make a more complete series. His results are shown in Fig. 28, herewith, in which the full-line curve shows the results of the experiments; and the dotted line, their position given by Lord Rayleigh's formula, $x = \frac{3}{4}\frac{\cos\alpha\, l}{4 + \pi \sin\alpha}$, where x is the distance between the centre of pressure and the centre of the plane, l is length of plane, and α is the angle of inclination of the plane to the line of motion. The small inset shows the shape and immersion of the plane. The work was left for his son to complete at Haslar some twenty years later. Rayleigh discussed the suction on the back of the blade and inquired as to the possibility of experiments in air at Torquay. There is also some correspondence in 1877 with Mr. (afterwards Sir John) Thornycroft, concerning the rudders for the Lightning. Some experiments tried in 1873 on a model of the Encounter, immersed 9·2 in. at the stern to test the relative efficiency of the top and bottom of a rudder, are of interest. A rudder was formed as shown in Figs. 29 and 30, herewith, the angle between the faces of each part being 5 deg. and the (mean) angle between the two parts, 31 deg. After being tried as shown, each piece was turned about so as to reverse the action. The bottom piece was in both cases the more operative, and the effect was nil when the top piece was inclined 20 deg., and the bottom 11 deg. When the model was at rest, the top of the upper piece was immersed about ¼ in. Generally, however, little of no analytical attention appears to have been given to the subject until 1885, when some experiments were carried out on a model of H.M.S. Ajax at Torquay.

The Ajax was comparatively beamy, flat-bottomed, of moderate draught, and of full lines, particularly aft. The ship suffered from a peculiar and dangerous tendency in requiring a large angle of helm to maintain course. This helm was sometimes to port, sometimes to starboard, and would remain to port or to starboard for an indefinite period, sometimes for days on end, sometimes for hours only, and suddenly change from one side to the other and remain in the changed position for a further indefinite period. The phenomenon and the model investigation were fully described in a paper read by R. E. Froude before the Royal United Services Institution in 1887. The model was fitted with a working rudder and was towed by an automatic arrangement permitting slight sheer, which actuated the rudder to correct the motion. Defective steering was revealed by the degree of variation of helm angle automatically recorded. R. E. Froude confidently concluded that the cause of the dangerous defect was non-symmetry of the eddy motion aft, and observed two streams of water meeting considerably off the middle line, resulting in a run of water across the stern to a junction of the streams. Previous full models tested at Torquay, for example, those of the Northampton and Devastation, had shown a similar phenomenon although less serious in tendency, and the ships were found to require slight helm to maintain course. Various expedients were tried on the Ajax model to remedy the defect, the most successful being the fundamental one of elongating the deadwood to reduce the bluffness of the lines. Froude suggested an extension of 36 ft. for a perfect cure, but this would have entailed an entire reconstruction of the stern and a compromise was effected with, on the whole, beneficial results. The model was tried without propeller and the arrangements were only an incomplete representation of the conditions of a self-propelled ship in other respects, but, despite these limitations, they were found completely adequate to assign the cause and cure of the trouble. These tests paved the way to that later utilisation of the experiment tank for investigations on rudders and steering, of which such full advantage is now taken.

The soaring flight of birds excited the interest of William Froude during his voyages at sea. Froude's analysis of the theoretical conditions of flight was accepted as throwing much light on the wider problem. He corresponded with Sir William Thomson, F.R.S. (afterwards Lord Kelvin), and others on the subject, and at the invitation of the former presented his views to the British Association Meeting of 1876. He had considered the subject as early as 1851 while on a voyage near Greece, and on his last voyage in H.M.S. Boadicea to the Cape, terminating in his death on May 4, 1879, he made observations of the soaring of the albatross and other birds, and wrote lengthy letters on this and other subjects to his family and to Sir William Thomson, one dated March 10, 1879, being the last in the Haslar records from his pen. Portions of some of the letters relevant to bird flight, subsequently published in the *Proceedings* of the Royal Society of Edinburgh in 1879 and 1888, included Froude's mathematical treatment and numerical solution. The 1888 paper was communicated by R. E. Froude, substantially as a paraphrase of his father's work. His observations suggested that birds at sea selected positions to leeward of the ship where eddies around the hull were excited by air flow and might readily have local ascending currents. He also suggested that, in a swell, a bird kept station over the maximum wave-slope to obtain the advantage of an up-current, and he evaluated by approximate methods that this current would be about 3 ft. per second in a wave 500 ft. long and 10 ft. high. The following abstract from the paper is reproduced as of some interest as regards wetness of ships :—

"'You know how in a heavy gale the sea surface seems to drift like dust? Well, in this case, the air was for a long time so full of sea spray up to a level of 50 ft. to 60 ft., that it looked as if a heavy April shower was passing, though there was a clear blue sky overhead, and sunshine. Now, whatever could carry spray to that height would answer the birds' purpose. To-day the birds are again about, but the wind is only a double-reef cutter breeze, if so much; and to-day, though they do a good deal of skimming, they

have also to do a great deal of flapping at intervals. As an explanation of the ascent of the particles of spray, Mr. Froude goes on to suggest that the frictional eddies in the air must receive their most effective renewal of energy from the friction on their undersides nearest the water surface, and that consequently their speed must be greater on the ascending side than on the descending side. The particles of spray passing across and through the vortices must be subjected alternately to the upward and downward forces due to the ascending and descending speeds. True, the ascending streams, being thinner in proportion as their speed is greater, will presumably act on the particles for a proportionately smaller share of the total time; but the resistance being as speed squared, the aggregate upward momentum imparted to the particles will nevertheless exceed the aggregate downward momentum. "This suggestion is interesting, as a plausible explanation of the phenomenon of the rising spray; at the same time, I hardly think the suggested operation can favour the soaring of birds except by the second order quantity." R. E. Froude concluded that the subsequent view of Lord Rayleigh, in 1883, that soaring is ascribed to the wind speed gradient at different heights, was a more satisfactory one generally, but that his father's explanation fitted the case of soaring in a swell and light wind.

The discussions of contemporary papers in the *Transactions* and those of other institutions afford abundant evidence of the value attached to the investigations at Torquay during their progress, and the esteem in which both William and R. E. Froude were held. Of particular importance is the unstinted praise of Sir E. J. Reed and of Sir Nathaniel Barnaby, who were successively responsible to the Admiralty for the design of H.M. ships and for the direction of the investigations carried out at Torquay. Mr. (later Sir William) White, who was also associated with the direction of the work at Torquay in its later years and became Director of Naval Construction subsequently, frequently expressed full and eloquent praise of the work. Admiral Sir Spencer Robinson, the Controller of the Navy at the time of the approval of the investigations at Torquay, and other naval officers of high rank competed with contemporary shipbuilders, engineers, and scientists in paying high tribute to the great importance of the work at Torquay. We even find Mr. J. Scott Russell, an opponent of the investigations in the first place, ultimately modifying his views to some extent. With the enormous expansion in the size, number and facilities of experiment tanks, and in the mathematics of fluid flow, great advances have been made in form and propeller efficiency, but many of the fundamentals established in those early days at Torquay still hold. One of the attributes of both William and R. E. Froude was their ability to attract capable assistants. The value of the aid afforded by the assistants at Torquay can be appreciated from the success they attained in later life; for example, Sir Philip Watts (1872), subsequently Director of Naval Construction; Mr. J. R. Perrett (1872-1885), subsequently chief naval architect of Sir W. G. Armstrong Whitworth and Company; Mr. F. P. Purvis (1873-1877), subsequently Professor of Naval Architecture at Tokio University; Mr. H. Pledge, C.B. (1881-1885), subsequently Assistant Director of Naval Construction and now the sole survivor of the Torquay assistants; and Mr. F. B. Ollis (1885-1886), subsequently Manager, Constructive Department, H.M. Dockyard, all served at Torquay in the periods named. Mr. E. R. Mumford, of the Torquay staff, left in 1882 to play an active part in the investigations carried on in the Dumbarton Tank. While foreign countries were slow to follow the Admiralty's lead in the establishment of an experiment tank, the records show that many naval attaches and other representatives of numerous foreign countries visited the works at Torquay, prior to experiment tanks being founded in their respective countries.

Special acknowledgment must be made to Sir Stanley V. Goodall, K.C.B., O.B.E., Director of Naval Construction, who gave permission for the paper to be prepared and the various results, diagrams, and photographs to be published. Further, as a member of the Board of Education Advisory Council of the Science Museum, he has initiated action and arranged for the transfer of some of the historical apparatus to the custody of the Director of the Museum, with a view to exhibition after the war in a setting appropriate to the work of Froude and the scientific aspect of naval architecture. The author is indebted to members of the staff of the Admiralty Experiment Works, Haslar, for the preparation of diagrams and photographs, and especially to Mr. W. Froude of the Royal Corps of Naval Constructors, who has supplied and verified many references to the work of his distinguished grandfather.

(*To be continued.*)

GREAT BRITAIN AND NORTHERN IRELAND AIR-MAIL SERVICE.—The Postmaster-General has announced that an air-mail service for letters, letter packets and postcards was put into operation on September 1.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the communicators are given in italics.

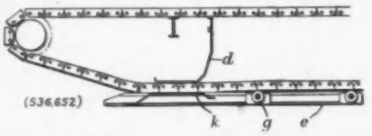
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

FURNACE APPARATUS.

536,652. Chain-Grate Stoker. The Illinois Stoker and Combustion Company of Great Britain, Limited, of London, and L. Morton, of London. (4 *Figs.*) December 6, 1939.—The stoker is for use with boiler furnaces and is of the type in which a chamber, known as the plenum chamber, extends between the upper and lower runs of the grate, in which combustion air is segregated and separately controlled. The chain grate is of known construction passing around a sprocket wheel at either end thereof. The lower run of the grate is supported on a series of flanged rails *c*, extending a short distance beyond each end wall *d* of the plenum chamber. Between



the rails, and mounted on them, are rows of rods carrying a number of rollers *g* with their circumferences slightly proud of the tops of the flanged rails. A series of baffles *k* immediately beneath each end wall *d* of the plenum chamber and between the flanged rails *c* seal the chamber so that the supply of combustion air to the plenum chamber is not affected if the front part of the stoker is opened up for inspection. If any of the rollers *g* become worn or damaged the chain grate at such part is carried on the flanged rails *c*, until repairs or renewal can be carried out conveniently. (*Accepted May 22, 1941.*)

SHIPS AND NAUTICAL APPLIANCES.

535,716. Warship's Ammunition Hoist. The Woodfield Hoisting and Manufacturing Company, Limited, of London, and C. A. Bandfield, of London. (15 *Figs.*) November 7, 1939.—The hoist is of the kind which consists of an endless-chain conveyor fitted with spaced heads which support and convey the rounds, and a pair of spring-opened shutters which control access to the conveyor at the lower level. The main object of the invention is to provide for silent operation of the conveyor, thus avoiding interference with any nearby sound-detection apparatus. The conveyor chains are fitted with spaced heads which support the rounds, and displaceable shutters 24 (Fig. 2) are supported by lever arms 25. The shutters are operated by positively geared timing mechanism consisting of spring-loaded face cams 28 which rotate on a stationary shaft 29 and are driven from the lower chain sprockets of the conveyor. One rotation of the cams is equal to the pitch of the heads and the cam profile gives the required closed and open periods of the shutters. The shutters are returned to the closed position by compression springs 35 housed within the shaft 29 and acting on the shutter-supporting lever arms 25, which are connected to cam followers 36 in the form of profiled sleeves. The stowing of the shutters in an open position during embarking is unnecessary, because the mechanism opens and closes the shutters at the correct times in both directions of travel of the conveyor. Moreover, the stowing of the retaining pawl 80 and the rendering inoperative of the non-return clutch are effected by a single lever 41 at the upper level of the conveyor (Fig. 1). The spring-loaded retaining pawl automatically projects into the hoisting path after the passage of each head, thus preventing the round from slipping back into the hoist tube should the operator lose grip of it during discharge. When the lever 41 is shifted to embarking position the pawl is pulled clear to the stowage position. The conveyor brake drum 42 is positively connected to the hand-winding gear, when this is brought into use for embarking, by the lever 41. When the hand-winding gear is operated in the embarking direction the ratchet clutch 39, 40, primarily meant as a safety device during hoisting, becomes a driver for the brake drum 42. The brake is automatically fully applied when each head reaches the unloading position. It can also be applied at any instant in an emergency. Hoisting is performed by power or hand gear, the drive being transmitted at the upper level to the main shaft 26. At intervals timed to suit the spacing of the heads the shutters 24 at the lower level are opened and closed under the control of the cams 28. In this motion of the conveyor, the teeth of the clutch part 39 slip idly past those of the other clutch part 40. Should the drive fail, reversal of the conveyor is prevented by the clutch 39, 40.

Fig. 1.

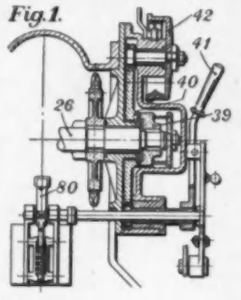
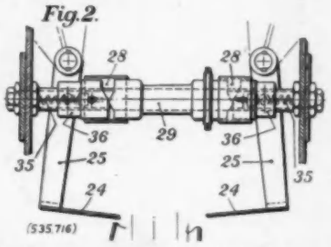


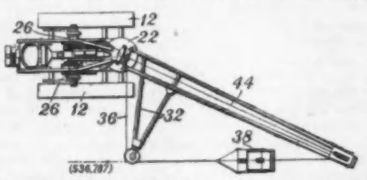
Fig. 2.



In order to embark ammunition, the hand lever 41 is turned counterclockwise, thus unlocking the fixed member 40 of the non-return clutch. The hand gear can now be operated to lower ammunition. The clutch part 39 now acts as a driver, and forces the brake drum 42 to rotate. While the conveyor is in full motion, the brake applies a light but adequate conveyor-sustaining hold upon the drum 42. (*Accepted April 18, 1941.*)

MISCELLANEOUS.

536,787. Dragline Excavator. Priestman Brothers, Limited, of Hull, and J. F. Smith, of Anlaby. (5 *Figs.*) March 7, 1940.—The excavator referred to is of the kind used in digging or dredging ditches and trenches. These excavators are often provided with a fixed boom, which extends to the centre of the ditch and over which the drag rope is passed to give a truly longitudinal pull. The fixed boom, however, causes wear of the rope if the jib is slewed to discharge the scoop. In the construction shown, the crane jib is hinged in the usual way on a turntable 22, which rotates about a vertical axis. Two wire ropes are wound round the periphery of the turntable and also round two winch drums 26 driven through clutches, one of which has a hand-operated brake that locks the shaft on which the clutches are keyed, and, therefore, locks the turntable. Attached to the jib is a triangular frame 32, which constitutes a lateral boom. At the end of this boom is



a sheave over which the drag rope 36 is led, this drag rope being attached to the dragline scoop 38. The sheave is mounted in a swivel fork so that it can tilt to adapt itself to the varying inclination of the rope 36. In use, the excavator is set with its tracks 12 parallel to the centre line of the ditch and the jib is slewed so that the jib head and the sheave are directly over the centre line. The brake is applied to lock the turntable and prevent any slewing of the jib. When the drag rope is hauled in, the scoop 38 will travel along the ditch. At the end of the cut, when the scoop is close under the base of the jib, it is raised to ground level by hauling in the rope 44, the brake is released and the jib is slewed to bring the scoop on to the bank. In addition, the jib can be raised, and, of course, the boom will be raised at the same time to clear the bank. The drag rope thus leads correctly over the various sheaves at all times, thus avoiding abnormal wear. (*Accepted May 27, 1941.*)